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STOPPING WATER POLLUTION AT ITS SOURCE

MISA
Municipal/Industrial Strategy for Abatement

MISA GUIDELINES FOR CONDUCTING A STORMWATER CONTROL STUDY

A Working Document For:

Ontario
Environment
Environnement

TD
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1992
MOE

Prepared by:

AQUAFOR ENGINEERING LIMITED
14 Abacus Road
Brampton, Ontario
L6T 5B7

In Association With:

BEAK ENGINEERING LIMITED
14 Abacus Road
Brampton, Ontario
L6T 5B7

and

DONALD G. WEATHERBE ASSOCIATES INC.
1352 Safeway Cres.
Mississauga, Ontario
L4X 1H7

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ONTARIO MINISTRY OF THE ENVIRONMENT
MISA Municipal Section
Water Resources Branch

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L4X 1H7

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1.0 INTRODUCTION AND BACKGROUND

1.1 Introduction

The Municipal–Industrial Strategy for Abatement (MISA) program has as its goal the "virtual elimination of all persistent toxic contaminants from all discharges into Ontario's waterways". The program is implemented by a series of sectoral **Monitoring Regulations** and **Effluent Limits Regulations** made under the **Environmental Protection Act**. One of the measures which must be undertaken in order to meet this goal is to control stormwater discharges from industrial and municipal sites. The **Effluent Limits Regulation** identifies the requirement to conduct a Stormwater Control Study (SWCS). This **Regulation** applies to all direct dischargers of treated process effluents to surface waters. It does not apply to indirect dischargers to municipal sewer systems.

This guideline document describes the key elements of a SWCS, and provides step–by–step guidance on conducting such a study. The Guidelines identify elements that should be considered in the development of the SWCS plan. Not all elements described may be required in all studies. Where optional or discretionary work is identified, decision–making criteria are presented. The discharger should use the most cost–effective techniques to fulfil site–specific stormwater control requirements. Proper use of the document requires application of engineering judgement, and knowledge of the **Environmental Protection Act** and MISA **Monitoring and Effluent Limits Regulations**.

Additional information in applying the Guidelines may be obtained from the Appendices which contain details of specific tasks and a worked example, and from the technical support document (**Development of MISA Technical Guidelines for Conducting a Stormwater Control Study**), which presents the rationale for establishing the Guidelines.

This document will be useful both to dischargers who are required to complete a SWCS, and to Ministry of the Environment staff who are responsible for reviewing and approving components of the SWCS implementation plan that require approval. The Guidelines may be used by other direct or indirect dischargers to assist in determining the need for control of stormwater discharges.

1.1.1 Organization of the Guidelines Document

The Guidelines document is comprised of nine chapters. The contents are summarized below.

Chapter 1: Introduction and Background: This chapter provides introductory material and sections dealing with; the purpose and scope of the Guidelines; goals and objectives of the MISA program and the relationship to stormwater controls; controlling legislation; objectives of a Stormwater Control Study; and a description of stormwater quantity and quality relationships. The intent of the chapter is to provide an understanding of the underlying factors that relate to the problem and the solutions.

Chapter 2: Administration of a Stormwater Control Study: This chapter defines the role of the discharger in carrying out the study in compliance with the Effluent Limits Regulation; and the role of the Ministry of Environment in recording all notices of industries initiating SWCS or applying for exemption and approving of SWCS components requiring ministry approval.

Chapter 3: Initiating a Stormwater Control Study: This chapter provides a step by step procedure for the study, including an outline of the study and the different phases.

Chapter 4: Exemption Assessment: This chapter identifies exemption criteria and describes procedures for conducting an exemption assessment and applying for an exemption.

Chapter 5: Screening Level Assessment: This chapter defines the process for collecting background information on the site and for completing a planning level assessment. Decision criteria for carrying on with a more detailed assessment are also presented.

Chapter 6: Detailed Study: Information relating to the study requirements for assessment of sources of stormwater pollution; including monitoring of flow and water quality, is provided in this chapter.

Chapter 7: Selection and Evaluation of Controls: Control options and various levels of protection provided by the different options are identified. Guidance is also provided to the discharger for selecting the level of protection which is best suited to the site specific concerns.

Chapter 8: Implementation: This chapter provides information on scheduling the components of the plan, cost factors, and compliance and reporting requirements.

Chapter 9: Minimum Requirements and Standards: Additional information for plan preparation is presented. This includes; minimum plan requirements; data standards for accuracy and quality control; report and data submission format. This chapter also includes check lists for use both by the discharger and the Ministry.

1.2 Background

1.2.1 MISA Program

The Municipal–Industrial Strategy for Abatement (MISA) Program was initiated by the Ministry of the Environment in 1986, with an ultimate goal of the virtual elimination of persistent toxic contaminants from all discharges into Ontario's waterways. More recently (**Issues Resolution Process Final Report Summary**, MOE, Sept., 1991), the Ministry has identified three overriding principles:

1. pollution prevention;

2. no cross–media transfer of pollution; and
3. zero discharge of specific persistent toxins.

Technology–based limits will be imposed on direct dischargers in **Effluent Limits Regulations** for each sector, based on information collected from their **Monitoring Regulations**. These **Regulations** are based on the best available technology economically achievable (BATEA). Indirect dischargers, i.e., industries which discharge process wastes into municipal sanitary sewer systems, are regulated under MISA through the Sewer Use Control Program. Many of these industries discharge contaminated storm drainage to surface waters. Such discharges may also be controlled through application of these Guidelines.

The MISA **Monitoring Regulations** include stormwater discharges for all sectors that have runoff. In addition, information on site drainage was collected as part of an initial submission of information required for each discharger. From this information, the Ministry established the need for control of stormwater discharges.

Specific control limits or methods were not established for stormwater because of the site–specific nature of the problem and potential controls. The Ministry of Environment decided instead to require all dischargers, as identified in Effluent Limits Regulations for each sector, to carry out a SWCS to achieve the goals of MISA. Any discharger may apply for an exemption for relief from the requirement to carry out a SWCS, provided that certain conditions are met. These conditions are described in Section 1.5. A detailed procedure for applying for an exemption is provided in Chapter 4.

1.2.2 Controlling Legislation

Effluent Limits Regulations are defined under Section 136 of the **Environmental Protection Act**. The requirement to do the study under the Regulation must be complied with or a violation will occur, resulting in potential enforcement actions. The Act provides penalties for violations.

Implementation of the plan may result in the construction of sewage works, which require the discharger to make an application for approval under the **Ontario Water Resources Act**. This Act defines "sewage works" to include storm sewers and stormwater control facilities.

Ontario's **Environmental Assessment Act** also applies to municipalities carrying out expansion or upgrading of storm sewage systems. In carrying out the Stormwater Control Study, municipalities should also satisfy requirements of the **Class Environmental Assessment for Municipal Sewage and Water Projects** (Municipal Engineers Association, 1987). Ideally, the SWCS would serve as an Environmental Study Report under the Class EA.

1.2.3 Objectives of a Stormwater Control Study

The purpose of the SWCS is to facilitate development of a plan for prevention and control of contaminated discharges from storm drainage sites and in so doing, satisfy regulatory requirements.

The specific study objectives are to:

- identify stormwater quality characteristics and loadings to the environment;

- identify sources of loadings;
- identify the need and priority for prevention and control based on the severity of the problem and the ease of control;
- recommend a specific prevention and control program of works and practices;
- establish an implementation schedule; and
- establish a follow–up monitoring and auditing program.

In developing the plan, the discharger should apply sound environmental principles. These principles are provided here and are applied throughout the document. These principles are consistent with the principles of MISA.

- **Pollution prevention is preferable to pollution control**. It is preferable to prevent contamination of stormwater at the source, than to control contaminated stormwater through a treatment program.
- **Contaminated streams should be separated from un–contaminated streams**. This will provide substantial benefits in reduced control costs.
- **Reduction, reuse and recycling wherever possible, is preferable to pollution control** of materials which normally enter the waste streams.

1.2.4 What Triggers a SWCS

The MISA Monitoring Regulations require the collection of a limited amount of water quality and flow data from specific outfalls. The water quality data which have been collected to date were compared with the effluent limits set for that sector and exceedances were noted.

The Ministry had three options for regulating stormwater discharges:

- develop an effluent limit for the discharge, based on best available technology;
- require a stormwater control study; or
- exempt certain dischargers from all requirements, except limited assessment monitoring.

In certain sectors and for certain types of effluent, the Ministry has chosen the first option. In the Electric Power Generation Sector, coal pile runoff has been defined separately in the sectoral monitoring regulation, and is expected to be regulated directly in the **Limits Regulation**.

For all other dischargers, the Ministry combined the last two options, and require that dischargers either carry out a SWCS, or apply for an exemption.

1.3 Review of the Problem

1.3.1 Definition of Stormwater Discharge Areas Subject to a Stormwater Control Study

The General Effluent Monitoring Regulation (Ontario Regulation 695/88) defines stormwater discharges as follows:

> "storm event" in relation to a plant means rainfall or a series of rainfalls on any day that in total exceeds five millimetres;
>
> "stormwater" means run-off from a storm event or thaw that is discharged from a developed area of a plant directly or indirectly to a surface watercourse;

> "stormwater effluent stream" means storm water that flows through an open or closed channel;
>
> "plant" means an industrial or municipal facility and the developed property and waste disposal sites associated with it;
>
> "stormwater sampling point" means a location in a storm water effluent stream situated before the place of discharge to a surface watercourse;
>
> "surface watercourse" means a lake, river, pond, stream, reservoir, swamp, marsh or surface drainage works;
>
> "thaw" in relation to a plant means the melting of snow or ice sufficient to create an effluent stream at the plant.

These definitions are provided here to differentiate between stormwater discharges and the other effluent monitoring points from an industrial plant site, such as process effluents, emergency overflows, once–through cooling water, and waste disposal.

The Regulations (and the SWCS) are intended to apply only to the plant site. However, drainage from non–developed areas of the plant, and drainage from outside the plant should be considered in a SWCS if they are located upstream of plant drainage and/or become part of the plant drainage.

Drainage from developed areas on a plant site may be sub–divided into categories such as:

- outdoor process areas, including outdoor production areas and material handling and storage areas, intermediate products, products, and by–products or waste materials, and roof or other drainage from indoor production facilities; and
- developed non–process areas, including parking lots and roadways.

A typical plant site including various effluent monitoring locations as defined in the **General Effluent Monitoring Regulation** and sectoral Monitoring Regulations is shown in Figure 1.1.

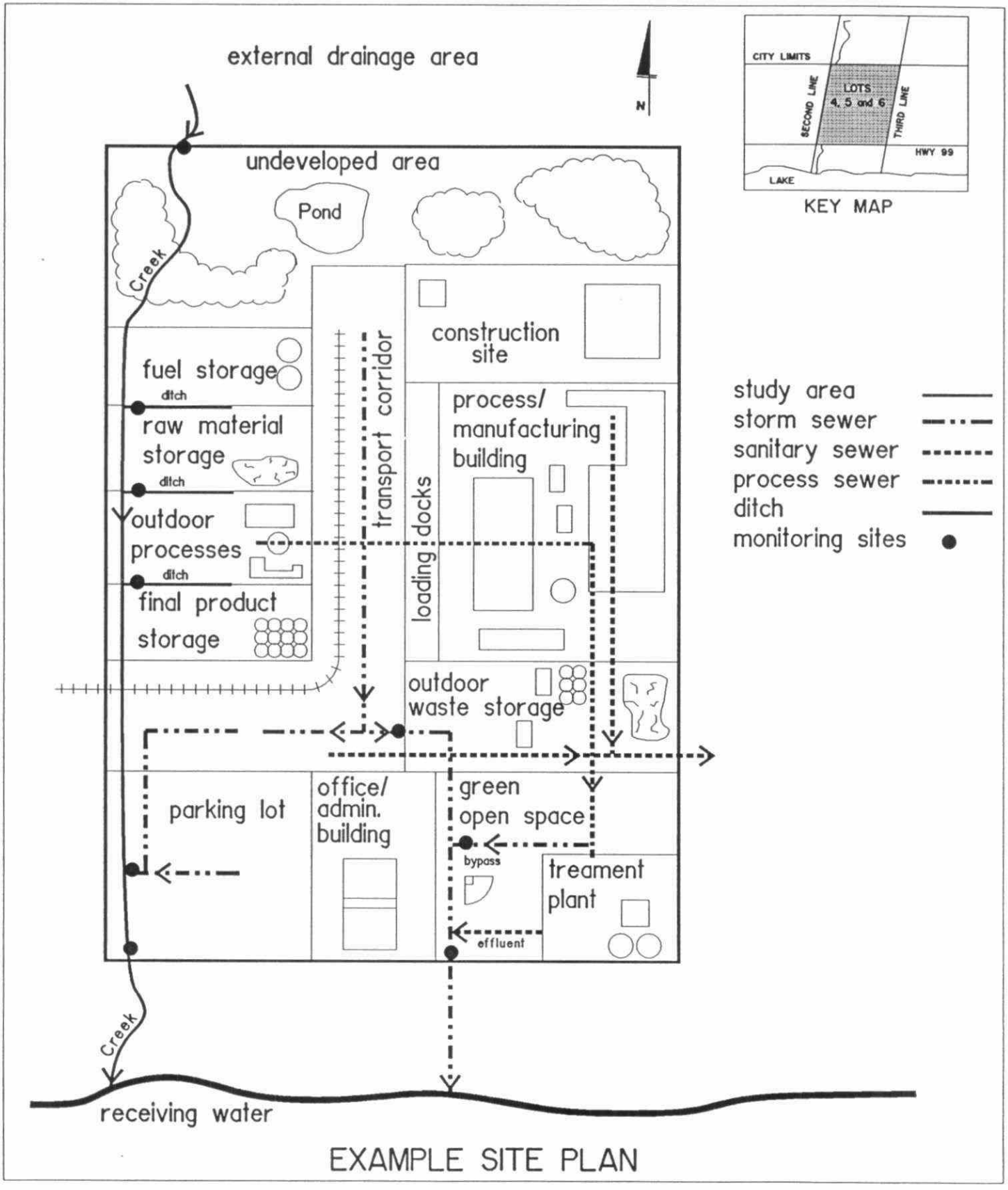
The area subject to the study includes:

- all areas draining to the stormwater sampling point identified in the Monitoring Regulation for that sector;
- other areas of the developed site, which may not have been sampled in the Sectoral Monitoring Regulation; and
- other undeveloped and off–site drainage areas which may be potentially beneficial to the study, i.e., if segregation of an undeveloped area or off–site drainage will reduce control costs.

1.3.2 Characteristics of Quantity and Quality of Stormwater Runoff

Urban stormwater runoff has been studied extensively, with well documented evidence of contamination. Sources of stormwater runoff include residential, commercial, institutional, industrial areas, associated and open spaces. One extensive study (Nationwide Urban Runoff Program – NURP, 1983) carried out in the United States, characterized several sites in each of the land uses, including industrial. Variation of contaminant levels varied widely between sites, land uses and storm events. No significant correlation was found with respect to land use, implying the characteristics of each site and its own contributing factors governed the contaminant level. The evidence of contamination has led the United States Environmental Protection Agency to develop regulatory requirements for industrial stormwater.

FIGURE 1.1



EXAMPLE SITE PLAN

The recent regulation notice (Federal Register, 16 August 1991) from EPA stated:

> "For some industrial facilities, the types and concentrations of pollutants will be similar to the types and concentrations of pollutants generally found in stormwater discharges from residential and commercial areas. However, stormwater discharges from other industrial facilities will have significant potential for higher pollutant levels."

The EPA notice also identified six activities as major potential sources of pollutants in stormwater discharges associated with industrial activities. These are:

- loading or unloading of dry bulk materials or liquids;
- outdoor storage of raw materials or products;
- outdoor process activities;
- dust– or particulate–generating processes;
- illicit connections or management practices; and
- waste disposal practices.

The potential for pollution from many of these activities may be influenced by the use and presence of toxic chemicals.

In Ontario, there is some information on the characteristics of drainage from industrial areas. (i.e., Upper Great Lakes Connecting Channel Study, 1988; Niagara River Toxics Committee Report, 1984). The following paragraphs briefly highlight some of the contributing factors to urban runoff quantity and quality.

An understanding of rainfall–runoff processes will assist in making decisions on study components and in developing prevention and control options. Of course, knowledge of the industrial processes and materials, and the plant site are also important. Many studies have indicated a correlation between land use activity, and the intensity of the activity on a daily

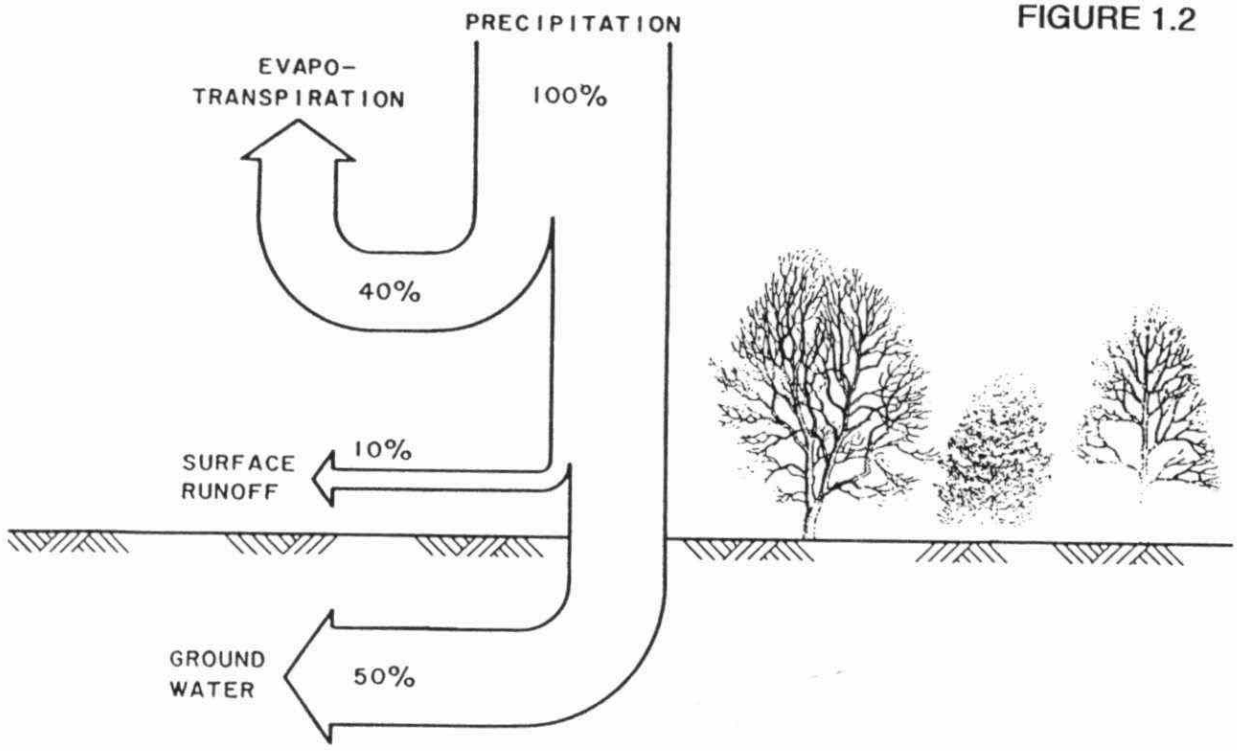
basis, i.e., volume of traffic, with the build–up of dust and dirt and associated contaminants. These contaminants are then available to be washed off as part of storm runoff. The assumption of daily accumulation with washoff related to rainfall events underlies many of the urban runoff models commonly used in industrial planning studies.

Rainfall strikes the ground and either percolates into the ground, ponds on the surface, or runs off. The impact of the drop will dislodge soil particles or dust and dirt particles accumulated on other surfaces. Runoff washes particles and oily materials off surfaces and carries them to drainage channels. Soluble contaminants are leached or dissolved in the flow. Many studies have noted that persistent contaminants, such as heavy metals, chlorinated benzene, and polynuclear aromatic compounds (PAHs) are strongly associated with sediments in stormwater.

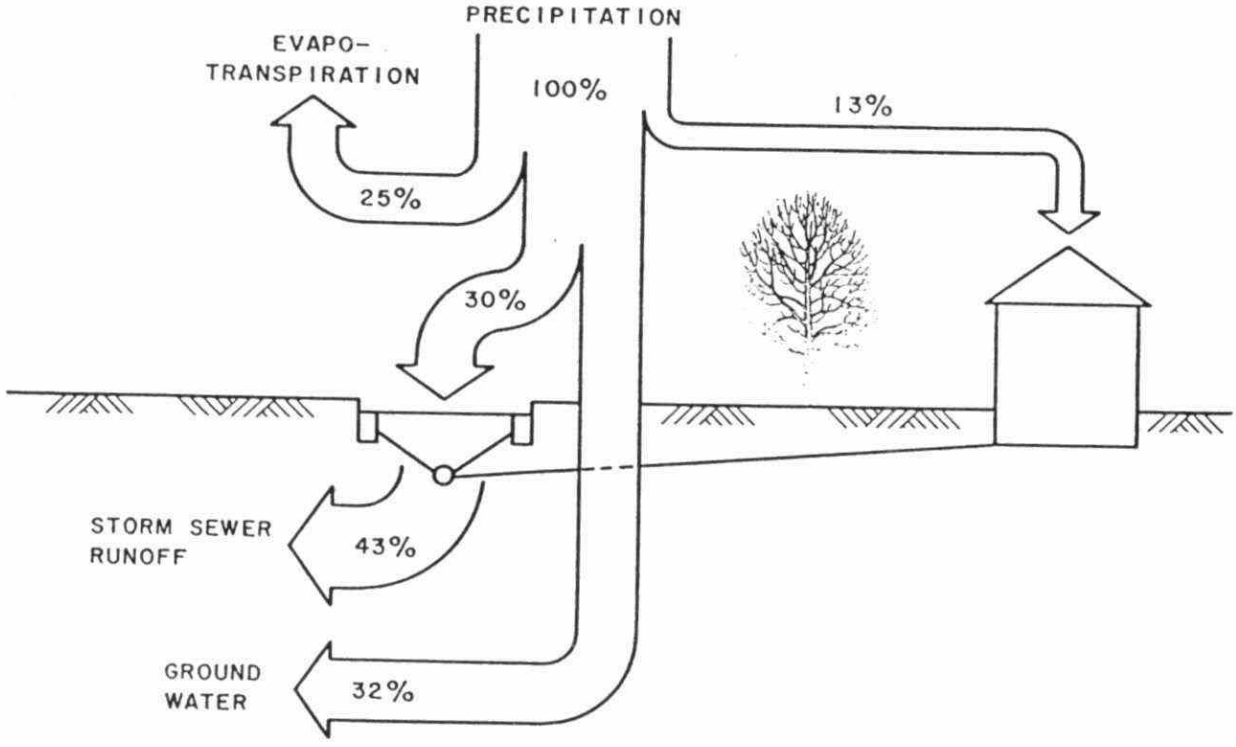
The development of land for the industrial site results in much of the area being paved or covered with structures. This increases runoff following a rainfall or snowmelt event, compared to the pre–development condition. Figure 1.2 indicates the relative runoff volumes resulting from land development through urbanization (and industrial development). In addition, improved drainage systems, such as graded land surfaces, parking lots, rooftops, curbs, gutters, catchbasins, swales, sewers, and open channels increase the flow rate off the site. Figure 1.3 shows the net effect on flow that results from increases in both the volume and rate of runoff from urban development.

Rain events occur randomly with varying frequency and magnitude, resulting in variable washoff rates and flow velocity (and hence in the mobilization of particles which account for much of the pollutant load in runoff). Contaminant loadings from runoff events are intermittent and generally occur over short periods of time. This often results in shock loading to receiving waters, similar a contaminant spill. Therefore characterization of runoff quality requires specialized monitoring techniques and control measures.

FIGURE 1.2



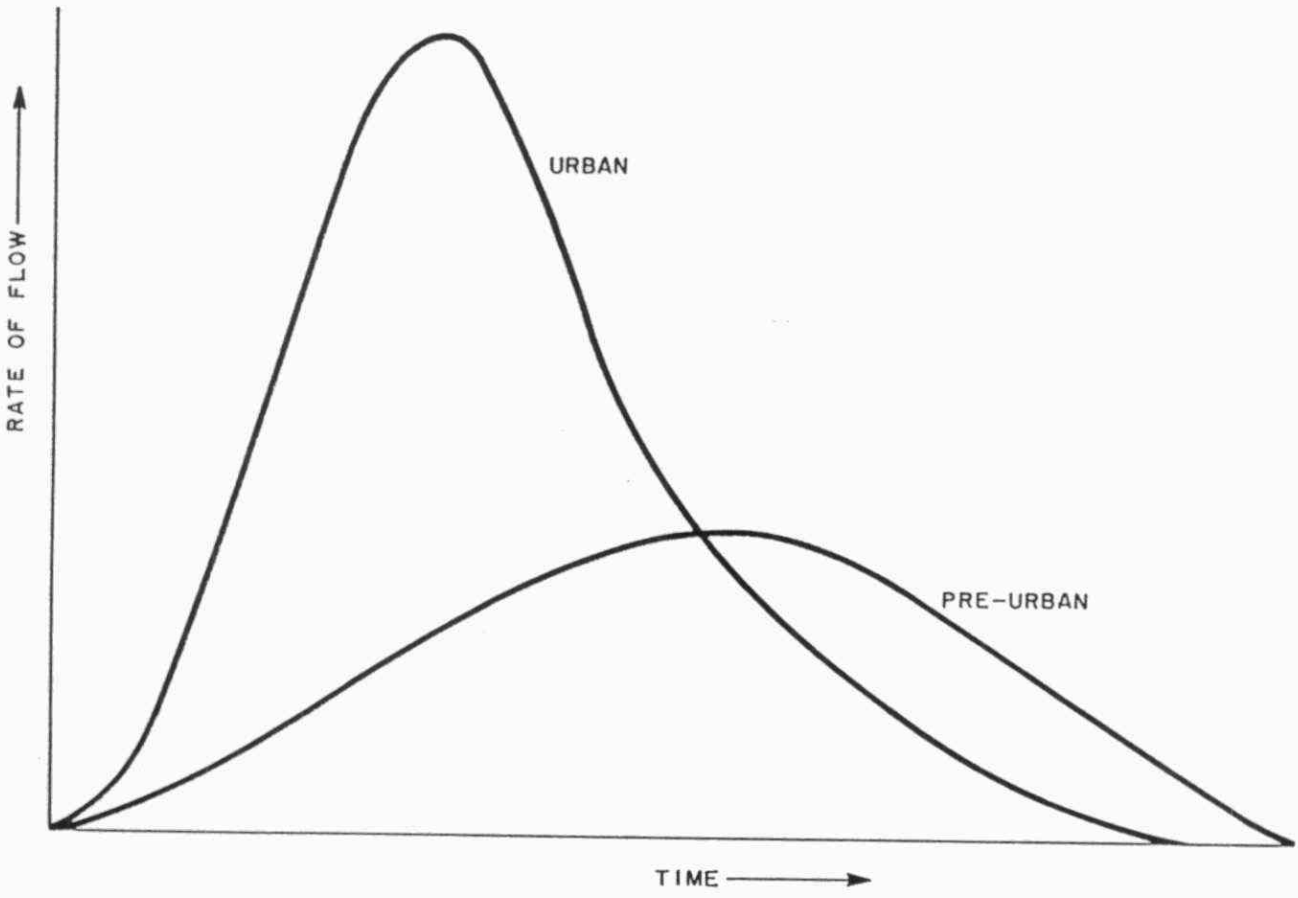
PREDEVELOPMENT



URBAN

HYDROLOGIC CHANGES RESULTING FROM DEVELOPMENT

FIGURE 1.3



DEVELOPMENT INCREASES PEAK FLOWS AND RUNOFF VOLUMES
(THE AREA UNDER THE CURVES)

Several actual or potential impacts on receiving waters are noted:

- Underground piping systems may be connected to or drain process materials or wastes, including sanitary sewage.
- Surface drainage from outdoor process areas will rapidly gain access to watercourses.
- Spills on any surface can gain rapid access to surface watercourses.
- Rain events will dislodge and wash off materials deposited or spilled in dry weather.
- Snowmelt events can quickly release materials deposited on the site over several months of the winter.

Table 1.1 summarizes some of the potential stormwater contamination sources by different drainage area land uses.

TABLE 1.1: POTENTIAL STORMWATER CONTAMINATION SOURCES BY DRAINAGE AREA LAND USE

Drainage Area Land Use	Stormwater Contamination Source						
	Washoff of Accumulated Contaminants						
	Dust/ Dirt	Oil/ Grease	Chemicals	Spill	Leachate	Soil Erosion	Connection With Other Water Uses
Non-Process Related							
External Drainage Area	✓	✓	✓	✓	✓	✓	
Undeveloped Land						✓	
Parking Lot	✓	✓	✓	✓			
Construction Site		✓	✓			✓	
Lawn			✓				
Office	✓						✓
Snow Storage/Disposal	✓						
Process Related							
Indoor Process/Manufacturing	✓	✓	✓	✓			✓
Outdoor Process/Manufacturing	✓	✓	✓	✓		✓	✓
Raw Material Storage	✓		✓	✓	✓		
Fuel Storage	✓			✓	✓		
Final Product Storage	✓		✓	✓			
Transportation Corridor	✓	✓	✓	✓			
Waste Storage and Disposal	✓	✓	✓	✓	✓		
Historical Storage/Process/Disposal					✓		
Process/Sanitary Treatment Plant	✓	✓	✓	✓			✓

2.0 ADMINISTRATION OF A STORMWATER CONTROL STUDY

2.1 Role of Discharger

The Sectoral **Effluent Limits Regulation** requires dischargers (companies and municipalities) to comply with the Protocol for the Preparation of a Stormwater Control Study Report. The responsibilities of the discharger (industry or municipality) under this protocol document include:

- meeting all milestones specified in the protocol document; and
- meeting the SWCS requirements outlined in the protocol document.

First, the discharger must initiate the study within the time limit specified in the Regulation. Within the time frame specified in the Regulation, the discharger must inform the Ministry of the Environment local district office of the initiation of the study, or apply for an exemption from the requirement to carry out the study.

The discharger should follow the various phases of the study as outlined in this document. This includes implementation of the preliminary assessment recommendations, which could consist of one or more of the following:

- detailed site investigation, including monitoring, assessment, and evaluation of prevention and control options;
- monitoring only; and
- immediate abatement actions, followed by monitoring.

The discharger must submit the completed report to the Ministry of the Environment.

The discharger should implement the SWCS plan, which could consist of one or more of the following:

- institution of Pollution Prevention Best Management Practices;
- construction of control works; and
- monitoring.

The discharger should fulfil any ongoing requirements as identified in the SWCS. Such requirements may include: reports on practices, events, operations and monitoring, to maintain records, and to operate structural measures and maintain best management practices.

Implementation of the remedial measures derived from the stormwater control study will not be part of the regulation. However, the implementation of these measures can be carried out using one of three options:

- issuing a control order;
- amending the effluent limits regulation; or
- delaying implementation until the next regulation update.

2.2 Role of Ministry of the Environment

The Ministry's role will be to record all notices of initiation of a SWCS and notices of intent to apply for exemption.

All exemption applications received by the director will be reviewed and a decision on the eligibility for exemption will be communicated to the direct discharger.

All completed SWCS will be recorded and kept on file by the director.

If sewage works are to be constructed, Ministry staff will review and approve applications made under the Ontario Water Resources Act.

Ministry staff may at their discretion inspect the works and best management practices to ensure compliance. In addition, monitoring reports submitted to the Ministry are maintained and made available to the public. The status of compliance with all requirements of the Stormwater Control Study plan including construction of works, monitoring and reporting requirements is also be made available to the public.

The Ministry of the Environment contact is the Local District Office.

3.0 INITIATING A STORMWATER QUALITY CONTROL STUDY

This chapter describes the key elements of a Stormwater Control Study. Section 3.1 provides an overview of the study procedure. Subsequent sections provide detailed descriptions of each study element.

3.1 Overview of Major Tasks

The major tasks involved in the study process are outlined in Figure 3.1. These tasks may be divided into four phases.

- Phase I: Initiate Study and Conduct Exemption Assessment;
- Phase IIA: Conduct Screening Level Study;
- Phase IIB: Conduct Detailed Study (As Required);
- Phase III: Develop SWCS Plan; and
- Phase IV: Initiate Long–Term Monitoring and Auditing.

These study phases are described below. The key technical or regulatory steps and the appropriate party that is responsible for carrying out the task are summarized in Table 3.1.

Phase I: Initiate Study and Conduct Exemption Assessment

1. The **Effluent Limit Regulations** for each sector identify all industrial or municipal sites required to do a SWCS. The industrial discharger is notified through the publication of the **Regulation**. Dischargers will have 4 years to submit a completed SWCS to the Ministry director.

2. The discharger (industrial or municipal site) conducts an exemption assessment and determines whether criteria for exemption are met.

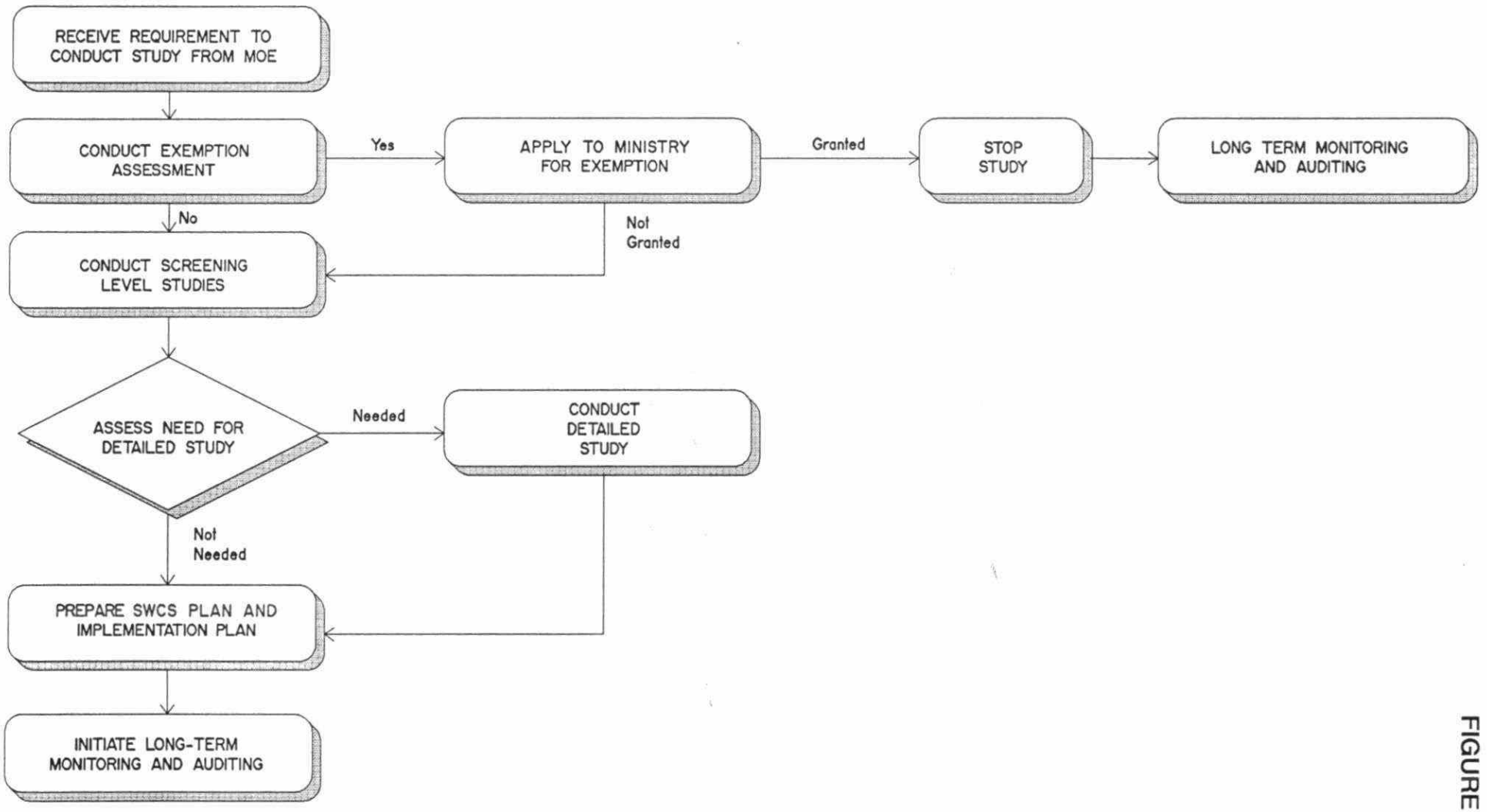


FIGURE 3.1

CONCEPTUAL PLAN FOR A STORMWATER CONTROL STUDY

TABLE 3.1: KEY SWCS TASKS

Study Phase	Key Tasks	Responsibility
Phase I		
Study Initiation	Requirement for study through promulgation of Effluent Limit Regulations	Ministry
Study Exemption	Industry determines whether or not to apply for an exemption, Ministry approves or rejects exemption	Discharger/Ministry
Phase II(a)		
Screening Level Study	Study initialization	Ministry
	Background data collection and review	Discharger
	Site mapping	Discharger
	Site inspection	Discharger
	Planning Level Assessment	Discharger
	Review of data to determine if a Detailed Study is required	Discharger
Phase II(b)		
Detailed Study	Site monitoring	Discharger
	Review of existing Stormwater BMP's or Controls	Discharger
	Basic or detail analysis	Discharger
Phase III		
Selection of BMP's and Controls	Identification of methods and alternatives	Discharger
Implementation Plan	Preparation of the Implementation Plan	Discharger
	Preparation and submission of the final report	Discharger
	Recording the completion and submission of the final report	Ministry
	Post study monitoring	Discharger
	Post study auditing	Discharger/Ministry

3. Applications for exemptions should be submitted to MOE within 6 months of notification of the requirement to conduct a SWCS.

4. If the exemption is granted, no SWCS is required. However, all conditions which are specified in the exemption must be met. Such conditions may include: long-term monitoring of site runoff, implementation and/or maintenance of management practices that contribute to maintaining acceptable runoff quality.

Phase IIA: Conduct Screening Level Study

1. If the discharger does not meet exemption criteria, or if the exemption is not granted, a SWCS is initiated. SWCS may include screening level or detailed studies. In general, the results of screening level studies would trigger detailed studies. However in some cases, it may be apparent that detailed studies are required. In such cases, a single study design incorporating screening elements would be prepared.

2. After completion of the screening level study, the discharger will assess the adequacy of the data for developing a list of structural and non-structural BMPs and for selecting options to achieve the different levels of protection (see Chapter 7 for criteria).

Phase IIB: Conduct Detailed Study (As Required)

A detailed study is required if the information obtained in the screening study is inadequate for assessing BMP alternatives, levels of protection and control, or if the system is sufficiently interconnected, then more information is required.

Phase III: Develop SWCS Plan

Based on the results of the SWCS, a SWC Plan is developed. This plan will include evaluation of alternative BMP's and control options to meet each level of protection, selection of a preferred option(s) to meet a specific level of protection, and development of an implementation strategy.

Phase IV: Initiate Long-Term Monitoring and Auditing

Long-term monitoring requirements (flow volumes, samples for chemical analysis, bioassay tests) and auditing of site practices (record keeping, housekeeping) are initiated.

4.0 EXEMPTION ASSESSMENT (PHASE I)

Some sites may be exempt from conducting a SWCS. This chapter identifies exemption criteria and describes procedures for conducting an exemption assessment and applying for an exemption.

4.1 Steps in Conducting an Exemption Assessment

The exemption assessment procedure is summarized in Figure 4.1. Key considerations in evaluating exemption assessments are presented in Table 4.1.

The key steps in the exemption assessment process include:

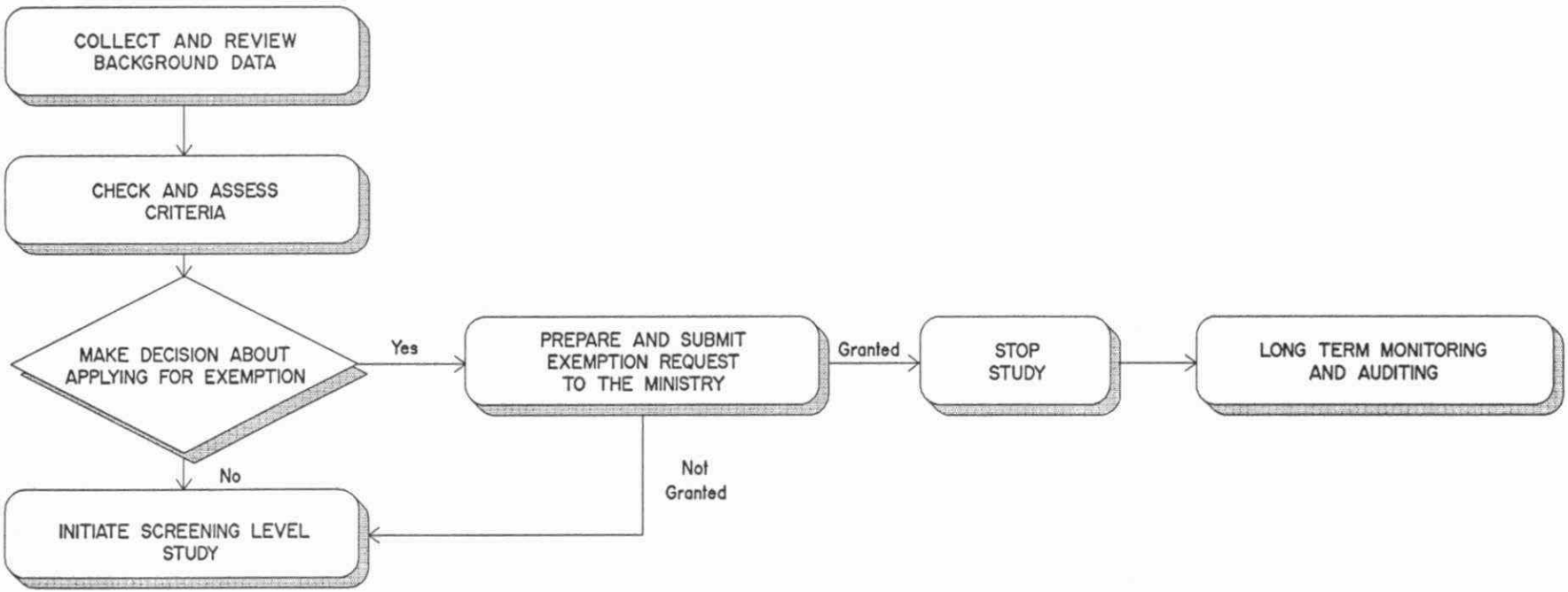
1. Collect background data for the site (as necessary to assess the exemption requests).

2. Compare background data to exemption criteria.

3. Submit to the Director a notice of the initiation of a SWCS within six months of promulgation of the Effluent Limits Regulations; or

   Submit to the Director a notice of intent to apply for exemption within three months of promulgation of the Effluent Limits Regulations.

4. Submit an Application for Exemption to the Director within six months of promulgation of the Effluent Limits Regulation.



CONDUCT EXEMPTION ASSESSMENT

FIGURE 4.1

TABLE 4.1: CRITERIA AND INFORMATION REQUIRED TO APPLY FOR EXEMPTION OF CONDUCTING A STORMWATER CONTROL STUDY

Criteria for exemption:

- if stormwater in sector is adequately controlled already (i.e., refinery may be adequately regulated);
- if whole drainage area flows to the MISA monitoring point or Certificate of Approval discharge point and the discharge water quality meets the BAT limits for that sector (i.e., the Level 1 Degree of Protection specified in Chapter 7); and
- if stormwater is mixed with industrial process water and is controlled as a process wastewater.

Examples of industries which may fit this category:

- petroleum sector; and
- mines in which all drainage area flows to tailings basin in which natural degradation assists contaminant reduction and water is recycled to mill.

Information required for Exemption Application:

- schematic showing plant layout and stormwater collection system;
- summary of MISA monitoring and other data to distinguish stormwater chemistry from process chemistry;
- show stormwater volumes relative to process water volumes;
- summary of housekeeping practices, site spills management contingency plan, summary of BMP plans;
- summary of site management practices and monitoring data which shows the current Level(s) of Protection; and
- proposed long–term monitoring and auditing plan.

5. After review of the exemption application, the Ministry may approve the exemption request, or may disallow the request or may require additional information. Should additional information be required, then an additional submission may be anticipated.

6. Should the Ministry decide the exemption will not be granted, the discharger will initiate a screening level assessment. Should the exemption be granted, the discharger would begin long term monitoring and auditing (see Figure 3.1, described in Chapter 3) using the monitoring plan presented in the exemption request.

4.2 Criteria for Exemption Application

Stormwater discharge sites may be considered for exemption in the following circumstances:

- drainage waters are regulated by a Federal statute;
- drainage water flows to a Certificate of Approval discharge point; or
- rainwater mixes with site process water and is controlled through wastewater treatment.

In order to be considered for an exemption, all dischargers must provide the background information required in the exemption application (Table 4.1). This includes:

- a schematic showing plant layout and stormwater collection system;
- a summary of MISA monitoring and other data to distinguish stormwater chemistry from process chemistry;

- a summary of stormwater volumes relative to process water volumes;
- a summary of housekeeping practices, site spills management contingency plan; a summary of BMP and controls;
- a summary of site management practices and monitoring data which shows the current Level of Protection; and
- a long–term monitoring and auditing plan.

Sites such as petroleum refineries and pulp and paper mills, in which wastewater discharges are regulated by federal statutes (eg., the Fisheries Act), may be eligible for exemption from SWCS. Similarly, sites where all site drainage water flows to a Certificate of Approval point may be considered for an exemption, provided that the background information clearly indicates that drainage waters are controlled to the same level as the BAT limits for that sector (i.e., see Chapter 7 for details on Levels of Protection).

Other types of sites will also be considered depending upon site–specific circumstances. Such circumstances may include the following.

1. Stormwater is adequately controlled.

   - If the stormwater is already controlled, e.g., some stormwater at oil refineries already is treated (Table 4.2).
   - If stormwater flow is mixed with other controlled discharges and thus receives treatment as a process effluent, e.g., mine tailings often include substantial components of site drainage and receives treatment (Table 4.3).

TABLE 4.2: INDUSTRIAL ACTIVITIES THAT MAY PRODUCE STORMWATER

	Rainfall Contacts Following Types of Operations					
	Raw Material Storage	**Product Storage**	**Industrial Roofs (e.g., enclosed building)**	**Industrial Production Units Open to Atmosphere (e.g., refinery areas)**	**Cooling Water**	**Process Effluent Prior to Treatment**
Pulp and Paper	✓		✓	✓		
Organic Chemical Manufacturing (e.g., petrochemicals)			✓	✓		
Inorganic Chemicals						
Iron and Steel	✓	✓	✓	✓		✓
Metal Casting (e.g., Foundries, Dye Casting)			✓		✓	✓
Mining (e.g., gold, silver, salt)	✓			✓		✓
Industrial Minerals (e.g., quarries)	✓	✓				
Electric Power Generation	✓		✓			
Petroleum Refining				✓		✓

TABLE 4.3: MAJOR TYPES OF MIXING OF STORMWATER WITH OTHER INDUSTRIAL WATER USES

MISA Industrial Sector	Product–Related Stormwater[1]	Stormwater Mixed with Cooling Water[2]	Stormwater Mixed with Effluent[3]	Separated Stormwater Areas[4]
Pulp and Paper	✓			
Organic Chemical Manufacturing	✓			
Inorganic Chemicals	✓			✓
Iron and Steel	✓		✓	
Metal Casting	✓	✓	✓	
Mining			✓	
Industrial Minerals	✓			
Electric Power Generation	✓			
Petroleum Refining	✓		✓	

Examples

(1) Rainwater comes in contact with raw material storage areas, product storage areas, industrial roofs, or other physical units (e.g., oil storage tanks, cat crackers, etc.).

(2) Clean cooling water mixed with stormwater from roofs etc.

(3) Examples: Catchment drainage and process effluent mix in tailings pond – mines; site (yard) drainage and process effluent treated in water treatment plant (iron and steel sector) or wastewater treatment plant (petroleum section).

(4) Parking lots and grassed areas discharge directly to streams.

2. The physical characteristics of the operation do not warrant a study.

   - The process areas are totally controlled, with no potential for stormwater contamination.

3. A satisfactory study has been performed previously.

   - A study has been completed that follows the sequence of the MISA Guidelines for conducting a SWCS.

4.3 Information Required in Exemption Application

A completed exemption application form (see Sheet _____; to be developed in the future) and the background information listed in Table 4.1 are to be provided in the exemption application.

5.0 SCREENING LEVEL STUDY (PHASE IIA)

SWCS screening level studies are generally conducted when the criteria for exemption are not met. The purpose of such studies is to assess the nature and potential effects of stormwater contamination for all drainage areas. Screening studies utilize existing data, site mapping and site investigations to categorize all drainage areas with respect to the degree of contamination, access requirements for additional studies, and evaluate prevention and control options. For some industries there may not be enough or any monitoring data, therefore, some monitoring may be required in this study phase. If there are existing BMPs and/or controls on the site, their performance is also evaluated, and the results of this analysis are reported in a Facilities Description Report.

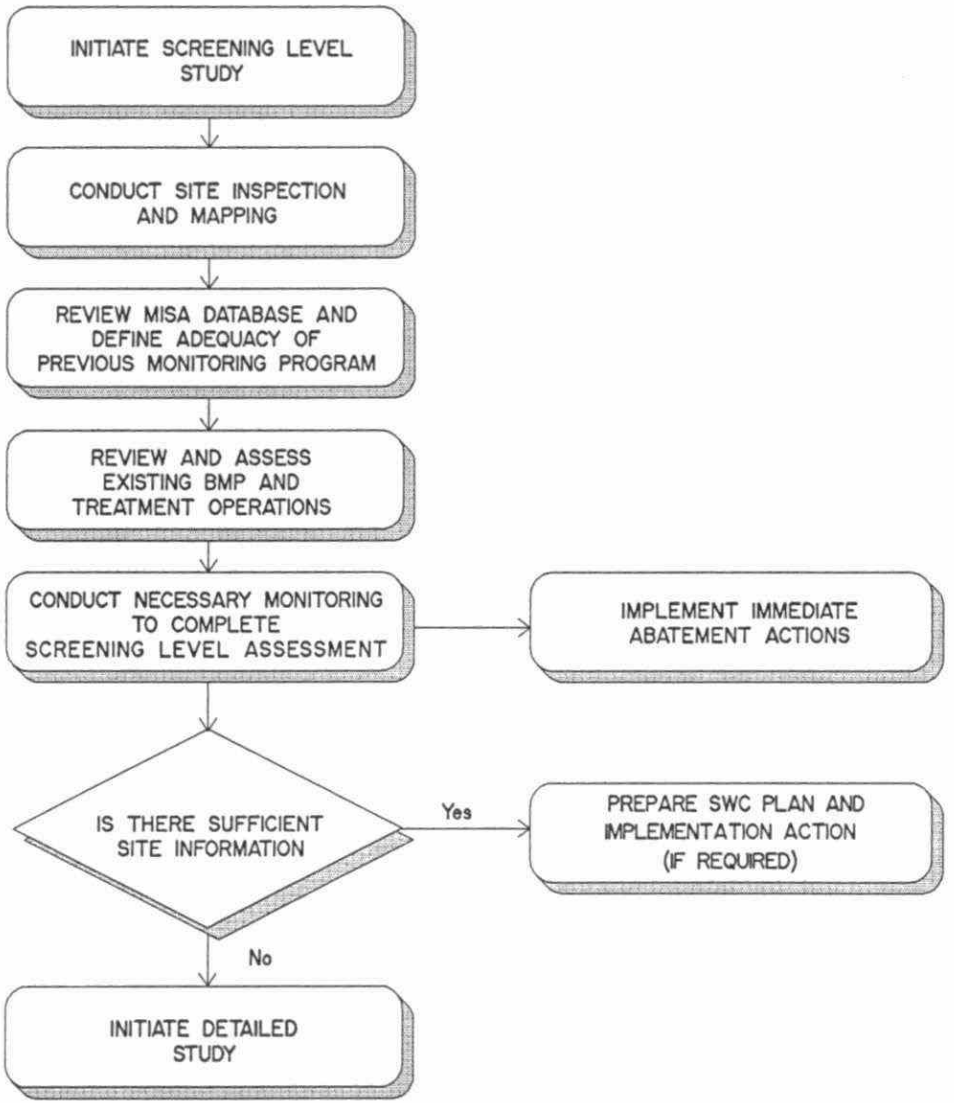
For some industrial and municipal plant sites the screening process may have already been prepared to some degree for the MISA Monitoring Regulations.

The key tasks comprising a screening level study are shown in Figure 5.1. The following sections describe the various tasks required to complete the screening level study.

An example of a catchment area assessment for a complete SWCS is provided in the Appendix.

5.1 Background Data Collection and Review

The objective of this task is to review existing information regarding the nature, cause and extent of stormwater discharges from the study area. In most cases the discharger will be familiar with the drainage characteristics and/or involved with stormwater control operations and best management practices on the site. They will have already compiled a considerable amount of information regarding their industrial site or plant from the MISA Effluent Monitoring Regulations. It is also possible that the local Ministry office who will be receiving the SWCS plan has information on the site plant.


INITIATE SCREENING LEVEL STUDY
CONDUCT SITE INSPECTION AND MAPPING
REVIEW MISA DATABASE AND DEFINE ADEQUACY OF PREVIOUS MONITORING PROGRAM
REVIEW AND ASSESS EXISTING BMP AND TREATMENT OPERATIONS
CONDUCT NECESSARY MONITORING TO COMPLETE SCREENING LEVEL ASSESSMENT
IMPLEMENT IMMEDIATE ABATEMENT ACTIONS
IS THERE SUFFICIENT SITE INFORMATION
Yes
PREPARE SWC PLAN AND IMPLEMENTATION ACTION (IF REQUIRED)
No
INITIATE DETAILED STUDY

CONDUCT SCREENING LEVEL STUDY

FIGURE 5.1

Therefore, the initial tasks of the Screening Study should provide the following:

- an identification of the company or plant under investigation;
- a presentation of the information collected and reviewed as it pertains to the quantity and quality of stormwater effluent leaving the study site; and
- an initial list of information gaps.

Upon completion of this task, the investigation team will have a general or detailed knowledge of the site under investigation, insight as to the specific and/or potential stormwater quality issues and a better understanding for the level of detail and scope of work that will be required to complete the SWCS.

A check list of the background information to be collected, reviewed and documented is provided in Table 5.1.

Information sources may include:

- Plant Initial Reports prepared for the MISA Industrial Monitoring Regulations;
- water quality samples and flow estimates (or measurements) required for other purposes (e.g., flood control, Certificate of Approval);
- water quality samples and flow measurements obtained for the MISA Industrial Monitoring Regulations;
- Ministry of the Environment Certificate of Approval for Stormwater Works;
- site or plant records for existing SWCS;
- site or plant reports from ongoing and previous studies prepared by the discharger/consultants, and others;
- site plans and engineering drawings; and
- information from the local Municipality and Ministry offices.

TABLE 5.1: BACKGROUND INFORMATION CHECKLIST

- Name of company
- Name of plant site
- Industry or sub sector
- Basic Products from the site/industry
- Site location and size
- Age of site and brief development history
- Site mapping and drainage plans (plan view of buildings, storage area etc.)
- General site topography (i.e., contour map)
- Natural and manmade drainage features
- Name of receiving waters
- Description of existing sewerage, and treatment facilities (include sewers outlet points)
- Previous existing flow monitoring and water quality sampling locations
- Existing water quality data and associated flow measurements
- Plant or site stormwater treatment facility records
- Proposed site development plans
- Unique site features
- Relevant conclusions from previous reports

5.2 Site Mapping

The objectives of using and preparing site maps are to obtain, understand, evaluate and present plant site information.

Site maps should be reviewed and developed for the **entire plant site**. A check list of the information which may be available and should be provided on site maps is provided in Tables 5.2a and 5.2b. It is important that the latest, most accurate information is used. Questionable information should be validated through a site inspection (see Section 5.5). Some mapping sources include:

- site plans and engineering design drawings;
- maps prepared from previous plant reports;
- MISA Monitoring reports;
- municipal maps, sewer plans and design drawings;
- Ontario Base Mapping; and
- aerial photography.

Maps prepared for the report will vary from site to site depending on the size and complexity of the site. For large, complex sites several maps may be required for clarity, each map highlighting specific site attributes, such as catchment area, land uses, and drainage systems/networks. All maps should have a key map for locating the study area.

TABLE 5.2(a): SITE MAPPING INFORMATION CHECKLIST

- property (study area) boundary;
- delineation of the drainage area serviced by each storm sewer outfall, discharge point or drainage ditch discharging to a surface water body. Large drainage areas with distinctly different runoff surfaces or land uses should be further delineated into sub–drainage areas;
- external drainage areas which discharge into the study area;
- the location, size and direction of flow for all natural drainage channels, streams, rivers, ponds, and lakes entering, within and exiting the study area. All receiving water bodies must be shown and labelled.
- the location, size and direction of flow for all constructed drainage swales, ditches, sewer systems (storm, combined, sanitary and process), sewer outfalls, effluent streams, emergency overflows (from treatment facilities and pumping stations) tanks, bypass diversions and ponds entering within and exiting the study area. All municipal sewer services and drainage ditches adjacent to the study area must be included. The map should clearly indicate what is natural and man–made;
- all runoff inflow sources which discharge to storm sewer systems or conveyance channels including catchbasins, floor drains, roof drains, and sewer access points;
- impervious areas including paved roads, parking lots, outdoor process areas and buildings;
- pervious areas including undeveloped land, open greenspace and outdoor process and storage areas; and
- existing structural control measures to reduce pollutants in stormwater runoff including containment berms, dykes, ponds, tanks and treatment facilities.

TABLE 5.2(b): SITE MAPPING INFORMATION CHECK LIST

- different land uses distinguishing between basic process and non-process related areas and related sub-areas, for example:

Process Related Areas	Non-Process Related Areas
Indoor production	Offices
Outdoor production	Parking lots
Raw material storage, handling and transport	Undeveloped land
Product storage, handling and transport	Construction sites
Waste disposal	Lawns
Historical storage, process and disposal sites	

- areas where pesticides, herbicides, oil conditions and fertilizers are applied;
- hazardous waste treatment, storage or disposal facilities;
- snow disposal and/or storage locations; and
- the location of all water quality sampling, flow monitoring and rain gauging stations.

All maps should be to scale, indicate the geographic north direction (on every map) and contain standard geographic coordinate references for remote sites.

5.3 Existing Best Management Practices

This section describes the information required to evaluate existing best management practices (BMPs). Existing BMPs are those specific facilities (structural controls) or procedures (non-structural controls) used to accomplish any of the following:

- manage site runoff and drainage from outdoor process and non-process areas resulting from stormwater or thaw events;
- control once through cooling water;
- reduce the frequency of effluent treatment system by-passes;
- manage sludge and residue/waste disposal; and
- minimize impact of spills arising from loading and unloading operations, in-plant transfers, process and materials handling.

At many industrial sites, contaminated stormwater discharges are controlled through treatment facilities (see Table 5.3). The evaluation of BMP should include but not be limited to the issues identified in Tables 5.4 and 5.5, and the water quality parameters listed in Table 5.6. The extent to which the BMP investigation must be carried out will depend upon the complexity of the site under investigation.

The results of the evaluation may be summarized in a Facility Description Report (FDR). This report may form the basis upon which conclusions can be developed regarding the adequacy of an existing facility and in determining if additional control measures are required. The FDR should emphasize the purpose and design basis of the existing BMP, its operating limits and present inadequacies and possible design and/or operation modifications to address requirements of the SWCS plan. The information required to describe an existing treatment facility in the FDR is summarized in Table 5.4.

TABLE 5.3: EXAMPLES OF LINKAGES BETWEEN STORMWATER SYSTEMS AND EXISTING TREATMENT FACILITIES IN MISA INDUSTRIES

Sector		Examples from Different Sites
1.	Petroleum Refining	• stormwater around storage tanks is collected, monitored for oily substances, and transferred to treatment systems, if contaminated • stormwater is collected in sedimentation lagoon and transferred to treatment system after rainfall is over
2.	Organics Chemical Manufacturing	• roof runoff and process water mixed • roof and parking lot runoff are completely separated
3.	Pulp and Paper	• runoff from building site and storage areas flows through sedimentation basin to receiving water
4.	Metal and Mining	• drainage area upstream of tailings pond flows into contaminated pond. Part of water is recycled to mill, the rest is discharged to receiving water provided it meets C. of A. requirements
5.	Iron and Steel	• contaminated yard drainage and from storage piles is pumped through high rate filtration unit
6.	Electric Power Generation	• storage pile runoff flows to receiving water
7.	Inorganic Chemicals	• roof drainage from near various vents is contaminated by minor amounts of zinc and flows to stream
8.	Metal Casting	• only water leaving the site is stormwater because all other aspects of industry are dry
9.	Industrial Minerals	• watershed runoff flows through the site into sedimentation ponds before discharging to receiving water
10.	Aggregate	• watershed runoff flows through the site in sedimentation ponds before discharging to receiving water

TABLE 5.4: DATA FOR DOCUMENTING EXISTING BEST MANAGEMENT PRACTICES (BMPs)

1. What is the BMP policy and its functional objective(s)?

2. Identify who is responsible for ensuring the BMP is properly managed.

3. Has the effectiveness of the BMP been proven and has there been any other measurable benefits arising from the BMP, such as pollutant removal for those listed in Table 5.6?

4. Have any negative impacts resulted from the BMP?

5. Is the BMP functional year round or only during certain time periods?

6. What are the capital, operating and maintenance costs of the BMP and if applicable, the staffing requirements to operating and maintain the BMP?

7. What is the intended or approximate lifespan of the BMP?

8. Does the BMP impact upon the human environment in any measure way (e.g., safety, liability, community acceptance)?

9. If the BMP includes a device, identify the basis of the treatment operation, its design and the siting/land requirements.

10. Are good housekeeping practices (i.e., spill cleanup, sweeping of process, material handling and parking areas, catchbasin cleaning, etc.) an integral part of the BMP?

11. Does the BMP plan incorporate any existing waste minimizing programs which may include source controls, loss prevention, waste segregation or special material handling and inventory practices?

12. Identify other factors which may have been considered in the development of an existing BMP including employee training, preventative maintenance and inspection and security concerns.

TABLE 5.5: ASSESSMENT OF EXISTING TREATMENT FACILITIES

Assemble and organize all relevant data outlined as follows:

- Treatment facility site plan identifying process, sanitary, storm sewers bypasses and proximity to process operations.
- Facility process flow diagram describing the location and capacity of inputs/outputs/bypass, treatment (size, purpose, nominal capacity of unit operations) and retention/equalization/recycling operations.
- Facility performance data including analysis of untreated and treated stormwater quality. This should include analysis of untreated and treated stormwater quality. This should include a description of sampling and testing equipment, procedures and schedules.
- Frequency of stormwater related surges or by–pass events.
- Quantities and waste classification of treatment residues/end–by products requiring disposal.
- Method, site and cost of residues disposal.
- Types and quantities of treatment chemicals for existing treatment facilities (labour, power, chemicals, disposal and maintenance) into process and stormwater components.
- Capital cost of effluent control, residue handling/storage or other related treatment facilities installed over the last 10 years.
- Information of any studies, performance reviews and legal actions completed over the past 10 years.
- Review of facility operating plans/procedures to accommodate extraordinary or emergency events.
- Applicable Ministry of the Environment Certificate of Approval documentation.

TABLE 5.6: WATER QUALITY PARAMETERS FOR REVIEW WITH EXISTING BMPs

Effluent Water Quality Parameters:

- bacteria (Faecal Coliform);
- suspended solids;
- nutrients (Total Phosphorus, Ammonia, Total Kjeldahl Nitrogen);
- trace metals;
- temperature;
- oil and grease;
- chlorides or salts;
- BOD (Biochemical Oxygen Demand);
- PCBs and PAHs (Polychlorinated Biphenyls and Polynuclear Aromatic Hydrocarbons); and
- other (toxic parameters, sector specific).

5.4 Site Inspection

The previous study tasks were based largely on existing information. However there are likely to be gaps, limitations or questions regarding this information. Examples of information gaps or questions which may arise are:

- is there evidence of spills in areas susceptible to stormwater runoff?
- is there external runoff going through areas of raw material storage?
- is there evidence of contamination at sewer outfalls?
- is there dry weather flow in the storm sewers?
- are the drainage facilities (catchbasins, sewers, outfalls) located and connected as shown on the drawings?
- do existing stormwater controls appear to be operating as designed?
- can runoff conditions vary due to the location and quantity of raw material and products stored on site?
- are all inlets and pipes accounted for?

A site inspection may answer some of these questions. The objectives of such an inspection are:

- to obtain a visual understanding of the entire study area and site conditions and operations;
- to collect additional information which may allow for a quick identification of potential stormwater contamination problems and solutions;

- to confirm questionable information obtained from the previous background and site mapping tasks; and
- to validate existing information.

An organized approach is required to conduct a successful and useful site inspection. This often requires the preparation of a pre-inspection plan, particularly for large study areas, and the use of inspection forms for thoroughness and record keeping purposes. The plan should contain a list of locations to inspect. The list should be prioritized to ensure the most important locations are inspected, tasks are performed, and an appropriate amount of time is allocated. An example of an inspection form is provided in Table 5.7.

Site inspections should take place under normal plant or site operating conditions. If possible, site inspections should be planned for both wet and dry weather conditions. Inspection for sources of sanitary or process drainage cross-connections should take place in dry weather and during normal business hours when these sources are typically greatest.

Several field crews may be required for complex and large sites. Each inspection crew should be experienced in site investigations, know the study objectives and be equipped with the following:

- inspection plan;
- site maps;
- necessary safety equipment;
- inspection form;
- pick to lift sewer access covers;
- flashlight;

TABLE 5.7: EXAMPLE SITE INSPECTION FORM

Site/Location/Description:

Investigator:

Date:

Site Type:

- ☐ Floor Drain
- ☐ Catchbasin
- ☐ Sewer Access Point
- ☐ Downspout
- ☐ Roof Drain
- ☐ Tank
- ☐ Berm/Dyke
- ☐ Pond
- ☐ Storage Area
- ☐ Outdoor Process Area
- ☐ Loading Dock
- ☐ Parking Lot
- ☐ Outfall Type:
  - ☐ Sewer
  - ☐ Pipe
  - ☐ Ditch
  - ☐ Swale
  - ☐ Spillway

Conditions:

Water Colour: _____

Odour: _____

Stains: _____

Notes/Dimensions/Capacities:

Conditions: (Cont'd)

Leakage: _____

Infiltration: _____

Flow: _____

- Direction: _____
- Depth: _____
- Velocity: _____
- Rate: _____

Water Sample:

ID/Log No: _____

Lab: _____

To Be Tested For:

- ☐ Suspended Solids
- ☐ pH
- ☐ Bacteria
- ☐ Nutrients
- ☐ BOD_5
- ☐ Metals

Including:

Sketch/Photo:

- camera; and
- sample equipment and bottles.

The sample bottles are useful should a flow of particular interest be observed during the inspection (i.e., spill, oily discharge).

When possible, an employee of the company should accompany the field crews(s) in order to answer questions as they arise or as required for safety reasons. The field crews must beware of all potentially hazardous areas on the plant site and the requirements for entry into confined spaces as per the Occupational Health and Safety Act.

5.5 Collection and Review of Stormwater Effluent Quality and Quantity Data

The purpose of collecting and reviewing stormwater effluent quality and quantity data is to identify whether there is an adequate monitoring database and to identify potential problems. The stormwater quantity and quality data evaluated in screening level studies usually consists of using existing grab or composite water quality samples and related flow measurements or estimates. For screening level studies it is generally too expensive and unnecessary to conduct an extensive monitoring program. However in some cases, such as for small plant sites or plant sites which require only a few additional samples to completely assess all drainage areas, a number of grab samples may be collected.

Grab samples are single samples taken at one point in time. They are typically used in stormwater control studies for investigative purposes to test for the presence or absence of a contaminant and where the use of other methods of manual or automated sampling techniques are not feasible or not suitable for the selected water quality parameters.

Grab samples must be collected during the initial stages of the runoff event where the washoff of contaminants is typically greatest. The sample volumes should be large enough for all the laboratory analyses to be performed.

Samples are typically collected by filling sample containers with flow from the main channel where stormwater runoff is well-mixed. Parameters such as dissolved oxygen, pH and temperature which change quickly with time must be measured in the field at the time of sampling. Other methods of sampling and flow monitoring procedures are discussed in Section 6.

5.6 Problem Identification

The significance of stormwater effluent contamination can be determined by comparing the available data to the concentration or loading objectives required for the various levels of protection. Each study drainage area should be identified as having a particular level of protection (Chapter 7). A problem exists for a site if its' identified level of protection does not meet any of the levels required by the MISA protocol document.

The severity of the problem should also be assessed to identify whether there is a need for immediate abatement action. The need for immediate abatement action is typically identified when the desired level of protection is frequently and significant exceeded and the source of the problem is known or can be identified with minimal investigation.

Based on screening level studies, four possible categories of further action for a drainage area can be identified:

- Category I: Detailed site investigation, evaluation, assessment and selection of the BMP;
- Category II: No further site investigations required, proceed to evaluation assessment and selection of the BMP;
- Category III: Immediate abatement action, followed by monitoring; and
- Category IV: No controls required at this time, monitoring only.

Screening criteria and examples of catchment areas for each category are presented in Table 5.8.

It is possible for a catchment area have a dual classification of I and III. This condition arises when there are several problems within the drainage area and one or more of which can be corrected by immediate abatement actions. If there is an insufficient database then the drainage area must be monitored as part of the detailed study phase.

TABLE 5.8: DRAINAGE AREA SCREENING CRITERIA

Category	Action to be taken	Screening Criteria	Examples
I	Full investigation, evaluation, assessment and selection of BMP	• monitored discharges exceed process effluent limits • limited information for areas with a high potential for contaminating stormwater runoff • observations of dry weather discharge	• By default • Outdoor process areas • raw material and product storage areas • loading docks • recently separated storm sewer systems
II	No further investigations required, proceed to selection of alternative BMP for all levels of protection	• the nature, sources and extent of contaminated stormwater runoff well defined based on existing data	• areas with existing SWC facilities not meeting process effluent limits
III	Immediate abatement action	• observations and/or measurement of contaminated stormwater where the source and causes can be readily controlled without extensive investigations	• cross connected sanitary and storm sewer system • partially separated combined sewer systems
IV	No controls required at this time. Continued monitoring and auditing	• undeveloped area in a natural state • no contamination expected or observed based on samples collected under Monitoring Regulations	• land use in the study area which is currently not in use and remains in a natural state. • land in the study area which is no longer in use and would not have contributed to the contamination of stormwater runoff

6.0 DETAILED STUDY (PHASE IIB)

The purpose of this chapter is to provide guidance on conducting a detailed study. This phase of the SWCS is carried out when the results of a screening level study identify a drainage area as Category I (see Section 5.6). There is generally little information regarding the quantity or quality of discharge from this type of site. Consequently, detailed studies generally involve site investigations, and data collection and analysis. This information is used to produce a detailed summary of stormwater quality and quantity for each drainage area, and to identify contaminant sources. The summary is used in the next phase of the SWCS to select alternative BMP plans and to prepare an implementation plan.

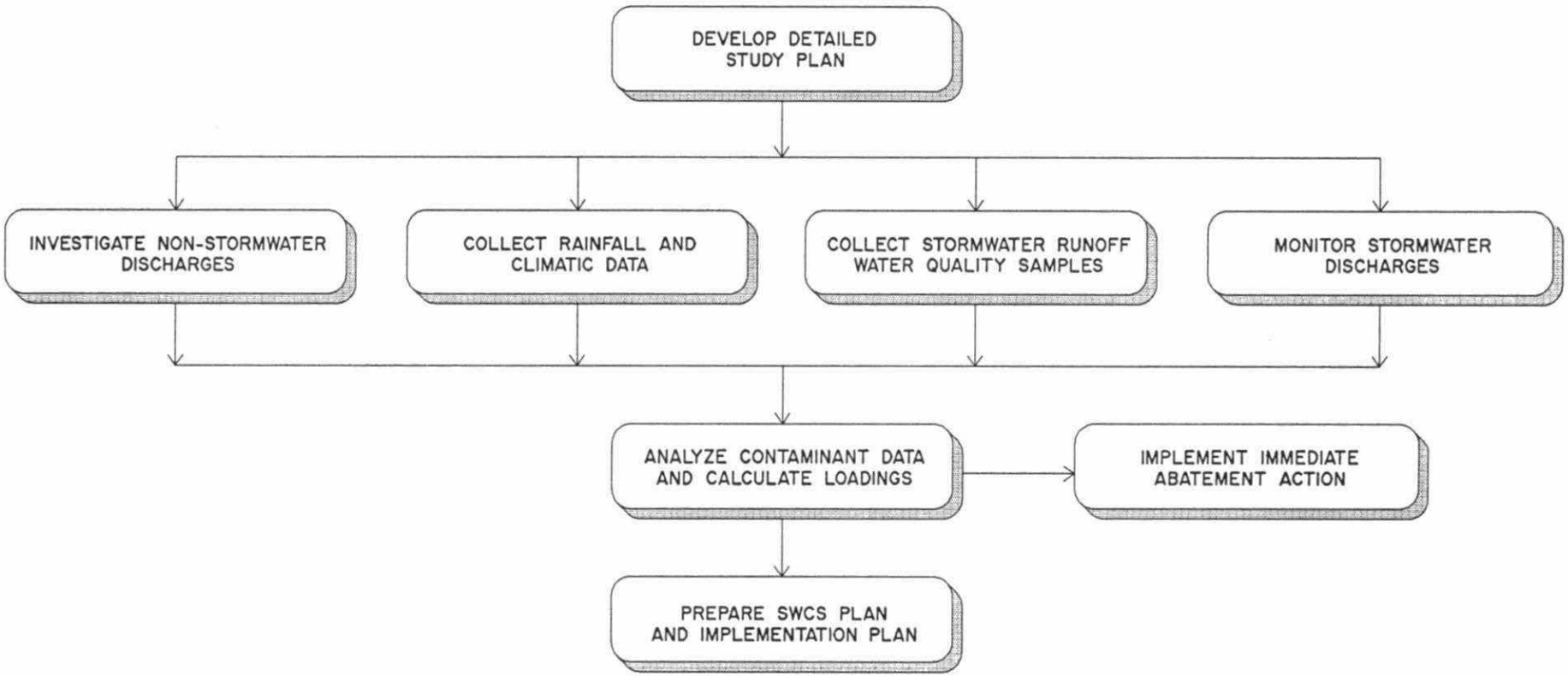
The key tasks comprising the detailed study are shown in Figure 6.1. These tasks include:

- investigating for the presence of non–stormwater contamination;
- collecting rainfall and climatic data;
- collecting stormwater runoff water quality samples;
- monitoring stormwater runoff discharge flow rates and volume;
- analyzing contaminant data; and
- calculating discharge volumes, flow rates and mass loadings.

6.1 Investigating Non–Stormwater Discharges

The purpose of this task is to identify the presence, extent and sources of non–stormwater discharges (NSWD). NSWD to a stormwater effluent stream may contaminate runoff and be a direct source of pollution during dry weather conditions. NSWD may enter into stormwater effluent streams as overland flow or by direct discharge. Examples of NSWD include:

- crossed or illicit connections between process or sanitary sewer lines and the storm sewer drainage system;
- spills which flow into catchbasins, floor drains or ditches;


DEVELOP DETAILED STUDY PLAN
INVESTIGATE NON-STORMWATER DISCHARGES
COLLECT RAINFALL AND CLIMATIC DATA
COLLECT STORMWATER RUNOFF WATER QUALITY SAMPLES
MONITOR STORMWATER DISCHARGES
ANALYZE CONTAMINANT DATA AND CALCULATE LOADINGS
IMPLEMENT IMMEDIATE ABATEMENT ACTION
PREPARE SWCS PLAN AND IMPLEMENTATION PLAN

CONDUCT DETAILED STUDY

FIGURE 6.1

- wash areas for equipment, machinery or vehicles;
- infiltration or seepage of contaminated groundwater;
- discharge from treatment facilities, lagoons or holding ponds;
- improperly dumped or stored materials;
- runoff from lawn watering which may contain nutrients and pesticides; and
- external flow sources.

Sources of NSWD investigations should:

- confirm the existence or absence of NSWD;
- identify the source of discharge;
- identify the times of discharge;
- quantify the daily volume of discharge; and
- quantify the quality of discharge.

Investigative techniques to provide the above information include:

- field observations for flow, stains, oil sheens, scum, sanitary waste and flow discolouration at outfalls and other appropriate observation locations (e.g., sewer access points, catchbasins, floor drains);
- displacement of objects (e.g., coloured balls or ribbon, or other indicators) strategically placed throughout the drainage system which may show that a NSWD had taken place;
- water quality sampling (24 hour composites) at the end of pipe or sewer outfall and throughout the drainage network, as required;

- flow monitoring at the end of pipe or sewer outfall and throughout the drainage network, as required;
- review and validation of accurate piping schematics;
- connectivity testing between drainage system with the use of water, dye and/or smoke; and
- closed circuit television (CCTV) inspection.

Details of the above inspection procedures are provided in the Appendix 1.

6.2 Rainfall and Climatic Data

The purpose of this section is to explain the need for suitable rainfall and climatic data, the types of data required and where and how to obtain the data.

Rainfall data are typically required for:

- correlating monitored flows to rainfall events;
- calculating event runoff volumes and peak flow for unmonitored drainage areas;
- detail event and continuous computer simulation modelling; and
- predicting typical annual runoff volumes for various rainfall conditions.

The source of all stormwater runoff is precipitation including rain, snow, hail and sleet. The variability of stormwater runoff quantity and quality is clearly dependent on the variability of precipitation intensity, duration, frequency, distribution, quantity (volume) and quality. The most important of these parameters when estimating pollutant loads is the precipitation volume. Precipitation volumes vary significantly from event to event, season to season, and

year to year. In order to determine representative runoff volumes, reasonable precipitation records must be collected.

It is important to know where and how to obtain the data early in the detailed site investigation as it will be required for use when conducting other site investigations, and, reviewing and analyzing monitored stormwater effluent discharges.

Rainfall data can be obtained in two basic formats:

- daily, monthly and annual summaries (in hard copy or computer files); and
- tipping bucket rain gauge (TBRG) charts.

The data format required will vary depending on its intended use. Table 6.1 summarizes possible rainfall data requirements, possible applications, and data sources.

The Canadian Atmospheric Environmental Services (AES) is likely to have the largest rainfall database for the analyses of historical events and typical rainfall conditions. However, data points may be located too far away from the study site for use with monitored discharges. The best source of rainfall data, particularly when used with the analysis of monitored events, is a gauge(s) located on the plant site. The gauge may be used for the detailed site investigation and subsequent studies and auditing of stormwater discharges.

The location of the rain gauge site is particularly important when analyzing monitored events. Due to the spatial variability of precipitation, it is desirable to have a rain gauge located as close as possible and practical (generally within 1 kilometre) to the catchment area(s) under investigation. For study sites in excess of 1 square kilometre, more than one rain gauge is recommended.

The location of each rain gauging station should be mapped on the site plan and described in the SWCS report. The description should also include information on the type and method of rain gauging used.

TABLE 6.1: RAINFALL DATA REQUIREMENTS

Type of Rainfall	Applications	Where or how to obtain
Intensity–Duration–Frequency (IDF) tables and charts	• rational method flow calculations • design storm runoff analysis for either spreadsheet or detail modelling approaches	• AES Canada
Single event hydrographs	• analyzing monitored and sample runoff events • calibration and validation of computer simulation runoff models	• AES Canada charts for closest TBRG stations • on–site TBRG stations
Continuous recorder for last 10 to 20 years	• predicting typical annual discharge volumes using detailed computer simulation models	• AES Canada • obtained by selecting a year with rainfall characteristics which closely match those of average conditions for 10 to 20 years of historical data. Characteristics to consider include total annual depth, number of events annually, and average event volume duration and intensity.
Average Annual distribution of daily rainfall volumes for range of daily rainfall (i.e., number of events between (0–2 mm, 2.1–5, 5.1–10 mm, etc.)	• predicting typical annual discharge volumes using spreadsheet or detail computer simulation models.	• processes from AES Canada historical data

Other climatic information such as degree days, air temperature, wind direction and rainfall quality may be useful for assessing melt conditions, seasonal variability of runoff and sources of airborne contamination. AES will be the primary source for this type of data.

6.3 Stormwater Effluent Monitoring

This section describes the requirements for stormwater effluent monitoring. Characterizing the existing quality and quantity of stormwater discharge for **Effluent Limits Regulation** provides:

- an understanding for the nature, source and extent of stormwater pollution;
- allows for the selection of the most effective controls; and
- may be used for follow–up discharge management and auditing of BMPs.

The first phase of the MISA program established the level of baseline monitoring for major industrial sectors. An example from the **Effluent Monitoring Regulations** for the Electric Power Generation Sector is presented below.

> **Effluent Monitoring Regulations for Electric Power Generation Stations: Monthly Monitoring – Stormwater**
>
> A total of twelve samples, including two samples taken during thaw events, are required during stormwater discharges at each affected stormwater sampling point. Thaw samples are needed to provide an indication of the losses of contaminants during the winter months.
>
> In cases where samples cannot be collected from a stormwater sampling point because of a lack of sufficient volume of discharge, an additional set of samples must be collected in the following months in order to provide a total of 12 data points.
>
> Samples should be collected towards the beginning of the discharge in order to catch the "first flush" effects. However, in cases where a retention structure

> is available to provide holdup time, a sample representative of the contents of the structure may be collected directly from the structure point to its discharge.
>
> The list of parameters to be analyzed reflect the process and plant areas from which the stormwater originates and passes through. Pre-regulation monitoring data was used for defining monitoring requirements.

The above level of monitoring provides the basis for identifying the potential for stormwater pollution problems. However, since stormwater runoff is a diffuse source or non-point source of pollution a more intensive level of monitoring is required by SWCS. Unlike process effluents, pollutants in stormwater cannot always be traced to a single source of contamination.

In general, stormwater sampling is coordinated with flow monitoring, however, there are investigations which can be conducted using one without the other (e.g., checking for the presence of dry weather flow or tracing for a specific contaminant at different locations within the drainage system).

The monitoring programs for water quality and quantity should be properly documented as required under the MISA **Effluent Monitoring Regulation** in the SWCS, and must follow all Specified Quality Assurance and Quality Control (QA/QC) requirements.

The monitoring requirements will vary for different types of drainage areas. This is due to physical monitoring constraints, the monitoring objectives (i.e., for screening level or detailed investigation) and land use activities. Table 6.2 provides a summary of monitoring requirements for typical types of drainage areas.

TABLE 6.2: MONITORING EXAMPLES REQUIRED FOR DIFFERENT TYPES OF DRAINAGE AREAS

1. Stormwater from roofs feeding through subfloor sewers to an outfall:

   (a) From internal downpipes:

   - for water quality parameters, grab samples to establish chemical characteristics from different portions of roof (e.g., near air pollution control units versus general dust accumulation areas); and
   - for water quantity estimates, area of roof times depth of rainfall.

   (b) For all storm sewers collecting roof runoff and discharging at one point:

   - for water quality:
     - grab sample for screening study, and
     - flow proportionate composite samples to establish Event Mean Concentrations;
   - for water quantity, continuous flow measurement for 3–5 events to establish baseflow (infiltration), runoff hydrograph and rainfall to runoff volume relationship.

2. Stormwater from roofs and product storage/raw material handling areas mixed with cooling water

   - For water quality:
     - grab sample during first flush for screening study, and
     - flow proportionate composite samples to establish Event Mean Concentrations;
   - For water quantity, continuous flow monitoring for at least 3–5 events to allow separation of hydrograph from cooling water flow and to develop rainfall to runoff volume relationship.

3. Stormwater mixed with treated effluent (e.g., mining application):

   - Water quality:
     - grab sample or composite samples dependent upon stream;
   - Water quantity:
     - use continuous flow measurement where possible, and
     - otherwise, apply a water quantity model.

4. Separate stormwater system draining parking lots, grassed areas or forested areas without significant site related activity:

   - Water quality:
     - grab or composite sample dependent upon purpose;
   - Water quantity:
     - develop rainfall depth to runoff volume relationship. Use water volume balance models or install continuous flow monitor dependent upon monitoring data objectives.

6.3.1 Sampling Locations

Selecting the appropriate sampling locations requires identifying the drainage areas of interest for detailed investigation and the suitable location(s) within the drainage areas. The drainage areas of interest are selected from the combined list of sites used to monitor stormwater effluents for the MISA Monitoring Regulations and the list of drainage areas screened as requiring detailed investigation by the Screening Level Study. The MISA list of sites will generally include the larger more obvious locations of stormwater effluent leaving the study area. The pre-screening list will likely include some of the Monitoring Regulation sites, plus sites such as external drainage areas, storage areas, roofs, parking lots, loading docks, influent and effluent of stormwater control facilities, internal subcatchments and new effluent streams (e.g., recently separated combined sewers and new storm sewers).

The sample location within a drainage area should represent as much as possible of the area of interest. Drainage areas with similar characteristics and pollutant sources may not need to be monitored. For example, if there were three drainage areas, one for raw material storage, 2 hectares in size and two for similar parking lots of 3 and 5 hectares in size, the raw material and 5 hectare parking areas would be sampled. **The SWCS report must clearly demonstrate how a drainage area is substantially similar to another drainage area in order to remove it from the list of areas requiring detailed sampling.**

Samples should be collected at the boundary between the study site and receiving waters in order to represent the quality of discharge from the entire drainage area. If there is no practical location for sampling at the boundary, then the first suitable location upstream should be considered.

The suitability of a sampling location within a drainage area is based on:

- safety;
- accessibility;
- a site which maximizes the surface area the samples will represent for both flow and water quality data; and
- requirements for acceptable flow monitoring (i.e., are adequate hydraulic conditions present).

If a contaminant is detected in stormwater runoff which exceeds the limits of a desired level of protection, then its **source must be identified**. The source may not always be obvious for some pollutants. In this situation, tracing the source will require sampling within the drainage area network. Samples may be collected in:

- sewer access points;
- catchbasins;
- roof drains; and
- surface drainage swales or ditches.

Samples collected during dry weather conditions will further assist in identifying possible contaminant source(s). Although it is desirable to have flow measurements with sample collection, it is not always possible when tracing sources of contamination. The flow streams may be too small or impractical to monitor.

6.3.2 Types of Samples

There are three types of samples which may be used for SWCS: flow proportionate composites, time proportionate composite and grab. The type used depends on the sampling

objective and site constraints. The following provides a description of these alternative sample types, when or where the type is used and sampling methodology.

Flow Proportionate Composite Samples

A flow proportionate or flow weighted composite sample is a single sample intended to provide the mean water quality for the entire runoff event, or the Event Mean Concentration (EMC). This method of sampling is used to account for the variability of runoff concentration caused by non–uniform washoff rates during a rainfall event. It is considered to be more representative of average runoff quality then time–weighted composites or grab samples.

Flow weighted composite samples may be collected by automatic sampling or manual collection techniques. Automatic sampling techniques collect a series of discrete, equal volume samples at a regular flow interval. The sampler is triggered by a flow meter, or by pre–programming at locations where flow discharge characteristics are known.

Time Proportionate Composite Samples

A time proportionate or time–weighted composite sample is a single sample intended to represent typical water quality for a period of discharge. Time weighted sampling consists of collecting a series of discrete, equal volume samples at a regular time interval. This method of sampling is only recommended for flow streams of relatively constant discharge or for investigative purposes such as required for identifying and quantifying dry weather or non–stormwater discharges. Typically, 24 hour composite samples are collected for this type of investigation.

Grab Samples

Grab samples are single samples taken at one instant of time. They are typically used in stormwater control studies to test for the presence or absence of a contaminant and where the use of other methods of manual or automated sampling techniques are not feasible or are not suitable for the selected water quality parameters.

Grab samples must be collected during the initial stages of the runoff event when contaminant washoff is greatest. The sample volume should be large enough for all laboratory analyses to be performed, on a single sample.

Grab samples are typically collected by filling sample containers with flow from the main channel where stormwater runoff is well–mixed. Parameters such as dissolved oxygen, pH and temperature which change quickly with time must be measured in the field.

6.3.3 Number of Samples

The quality of stormwater runoff will vary for each rainfall event. Variations are due to several factors, the most significant of which is the variability of activities within a given drainage area (e.g., a spill which may be washed off for one event may not be there for the next event), and the rainfall–runoff processes (e.g., the variability of rainfall intensity, duration and volume). The variability may be insignificant for some drainage areas, in which case a statistical average or Average Event Mean Concentration (AEMC) can be calculated. For other drainage areas, there may be a distinct relationship to land use activities or runoff volumes.

Collection of several water quality samples is required in order to investigate the relationship of stormwater quality to physical drainage and runoff characteristics, and to select or prepare the concentration data most appropriate for detailed analysis.

The number of samples to be collected is a function of:

- the purpose of the sampling (i.e., is it to be used to test for the presence or absence of contamination or to obtain the Average Event Mean Concentration (AEMC);
- the requirements for Quality Assurance and Quality Control (QA/QC); and
- the quantity of data available from previous monitoring programs.

When testing for the presence or absence of a contaminant, a minimum of three samples is suggested. If one sample is found to exceed a BAT limit, then detailed sampling is required for the drainage area.

Typically, a minimum of six to eight flow proportionate composite samples are required to determine the relationship of water quality to drainage area and runoff characteristics or for determining the Average Event Mean Concentrations (AEMC).

An additional 15 percent of the required number of samples should be collected for QA/QC purposes. This would include field duplicate, replicate and blank samples (see also MISA Monitoring Regulations for QA/QC).

Data collected for in previous studies, such as the MISA **Monitoring Regulations** or other sampling programs may be used provided:

- all QA/QC requirements for sample collection and handling were met; and
- water quality data are representative of the drainage area.

6.3.4 Pollutants to be Analyzed

Pollutants to be analyzed in stormwater effluent streams have been separately identified for each individual sector, sub–sector and municipal plant site in the MISA **Monitoring Regulations** (see Appendix 1). The pollutant lists are based primarily on possible contaminants from constituents associated with the manufactured products and process effluent streams. Analyses are required for the following pollutant groups:

- general chemistry (e.g., COD, DOC, Ammonia, Nitrates, Nitrites, TP, TSS, oil and grease);
- heavy metals; and
- PCBs.

When sampling for the presence or absence of a pollutant in stormwater effluent streams, a wide range of pollutants must be investigated due to the variety of possible contaminant sources for a drainage area (e.g., atmospheric, vehicular traffic and process sources) and the stormwater drainage systems or network. The list must include pollutants previously investigated in each of the above pollutant groups for the **Effluent Monitoring Regulations** plus scans for pollutants in the following groups:

- organochlorine pesticides;
- chlorobenzenes;
- polynuclear aromatic hydrocarbons (PAH); and
- bacteriological (faecal coliform and *E. coli*).

Although the use of organic compounds may not be directly applied to runoff surfaces, their presence in stormwater runoff and exceedance of Provincial Water Quality Objectives for surface water has been documented.

Sampling and analyzing for bacterial contamination is a good means of detecting possible cross-connection with sanitary drainage systems. In some regions of the Province, bacterial contamination of receiving waters is a major concern.

A list of specific water quality parameters for analysis is provided in Appendix 1.

The list of required pollutants for investigation must not be changed unless there is evidence to prove that:

- there are pollutants of environmental significance not included, in which case they should be added; and
- required pollutants are demonstrated not to occur at significant concentrations, in which case they may be deleted from the list.

Detailed justification is required for each pollutant removed from the list.

To minimize the costs associated with monitoring programs, follow-up sampling to trace sources and determine the AEMC should focus on individual pollutants identified as being present in significant concentrations.

6.4 Flow Monitoring

The purpose of a flow monitoring program is to collect actual site data to:

- quantify the rate and volume of stormwater runoff to directly estimate contaminant loadings;
- calibrate and validate computer simulation models (if required);
- design stormwater control facilities;

- quantify the rate and volume of dry weather on non-stormwater related discharges;
- identify the duration, frequency and timing of intermittent dry weather discharges and treatment facility bypass events;
- investigate the performance of existing stormwater treatment facilities;
- trigger water quality samplers; and
- identify the type of relationship between event flow volume and runoff pollutant concentration.

Flow monitoring is an integral part of the water quality sampling program. When using temporary or portable monitoring equipment, the monitoring location is typically governed by the flow monitoring location. Generally, there are more constraints associated with selecting a suitable flow monitoring location than there are for sampling.

The constraints for selecting a suitable flow monitoring location vary with the type of monitoring equipment to be used, the principal behind the measurement techniques and the type and shape of conveyance channel or pipe. Each of these constraints is affected by or affects the hydraulic flow conditions to be monitored. Hydraulic conditions to be considered when selecting a suitable monitoring location, measurement technique or equipment include:

- maximum and minimum depth range;
- maximum and minimum velocity range;
- maximum and minimum flow rate range;
- backwater effects;
- flow type (i.e., open channel or pressurized flow or both);

- flow state (i.e., laminar or turbulent); and
- quantity of solids transported either in suspension or along the channel bottom.

There are a variety of techniques available for measuring flow, including:

- slope, hydraulic radius and area (Chezy–Manning formula);
- hydraulic structures or primary devices (flumes, weirs and others);
- velocity–area;
- dilution (fluorometers and others); and
- timed volume.

There are several commercially–available products which use these techniques. There is also extensive literature which discusses the theoretical and operating principals of each technique. Selection of the most appropriate method depends on such factors as intended application, required accuracy, site constraints, and cost. Table (to be included) provides application and site limitation information with respect to each method which will assist in selecting the most appropriate method.

The current MISA **Monitoring Regulations** requires an overall accuracy of ±20 percent for measurements of stormwater effluent. This accuracy is considered reasonable for the purpose of the SWCS. The accuracy of the measurement is a function of the equipment limitations, site conditions, quality of installation, instrument calibration and maintenance. The accuracy of all flow monitoring installations should be checked and presented in the SWCS report. The accuracy of a temporary installation can be assured through hydraulic profiling using independent manual level and velocity measurements.

A sufficient number of flow measurements should be obtained such that they may be used for either one of the following approaches:

1. Measurement approach, where many measurements are obtained of average or typical runoff conditions which represent a high percentage of the annual precipitation events (not volume) which wash off surface pollutants. (For example, 90% of the daily precipitation events in Toronto are less than 15 mm, however, less frequent events greater than 25 mm represent a significant percentage of the total annual depth of precipitation). As a guide, each monitoring site should measure the runoff volume for three 5 and three 10 mm events, two 15 and two 20 mm events, and one event greater than 20 mm; or

2. Predictive approach, where few measurements are obtained which are suitable for the calibration and validation of computer simulation models to estimate the quantity of runoff under different rainfall conditions. As a guide, 3 to 4 events with volumes of 5 to 20 mm would be reasonable.

6.5 Analysis of the Contaminant Data

Contaminant data is analyzed to:

- assess the frequency and magnitude to which the contaminant was detected and the Event Mean Concentration (EMC) exceeded the desired levels of protection;

- calculate the Average Event Mean Concentration (AEMC) for each parameter and catchment under investigation for the purpose of estimating typical contaminant loadings;

- prioritize catchments and contaminants for control;
- identify contaminant sources; and
- select and design BMPs for pollution prevention and control.

The detection frequency and the magnitude by which the contaminant exceeds the water quality criteria is calculated by counting the number of times a given contaminant is greater than the analytical detection limit and the specific water quality criteria, respectively. Results may be expressed as a number and percentage and presented in tabular and/or graphical form.

A high detection frequency indicates the potential contaminant is readily available from within the drainage area. Water quality parameters with a high detection frequency may or may not be indicative of a water quality problem. A high frequency of detection may indicate a contaminant loading problem from a dry weather source. However, if the concentrations are well below water quality criteria and the desired level of protection and the runoff volume is relatively low, then the contaminant is likely not of concern.

A water quality parameter which exceeds water quality criteria may represent a potential toxicity problem. Exceedance of a water quality objective by an order of magnitude or more with a low frequency of detection may indicate an intermittent contaminant source. exceeding a water quality objective with a high frequency of detection may indicate a standard plant operation problem or a possible cross–connection with other sanitary or process sewer drainage systems.

The variability and consistency to which the contaminant may occur in stormwater effluent may be identified by examining the coefficient of variation of the EMC database. Detailed

review of the above data may also help to identify or validate sources of contamination. These data should be presented in tabular and graphic form for each parameter analyzed in each drainage area, see Figure 6.2.

The AEMC is obtained by calculating the arithmetic mean of the sampled event mean concentration (EMC).

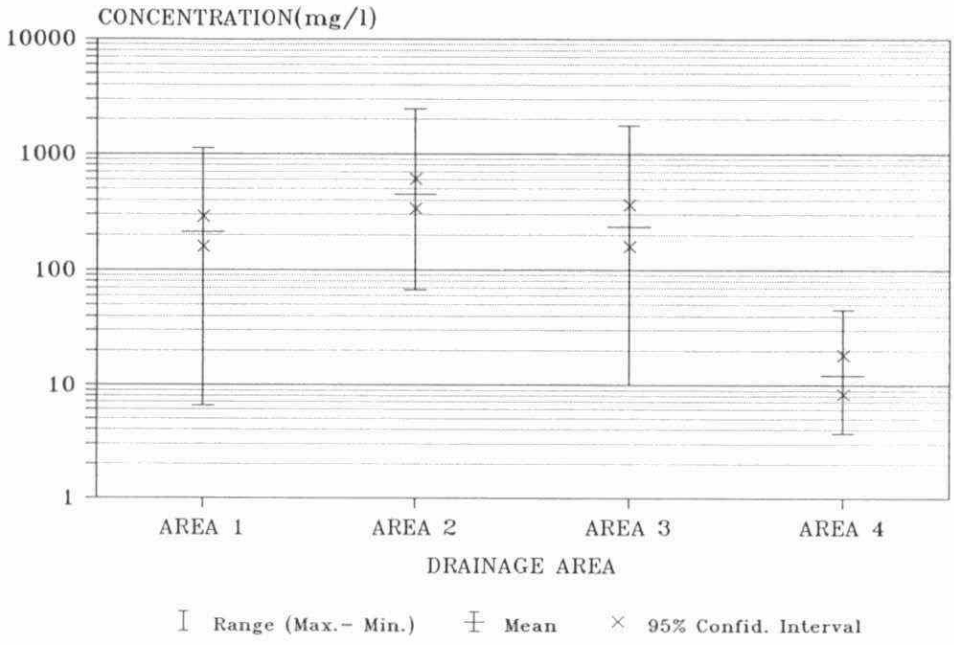
When calculating the AEMC, there are a number of potential biases which may affect the results of the analysis including:

- whether the concentration data are distributed normally, log normally, etc.;
- the presence of outliers;
- auto correlation in the data;
- correlation between parameters; and
- number of non–detect samples.

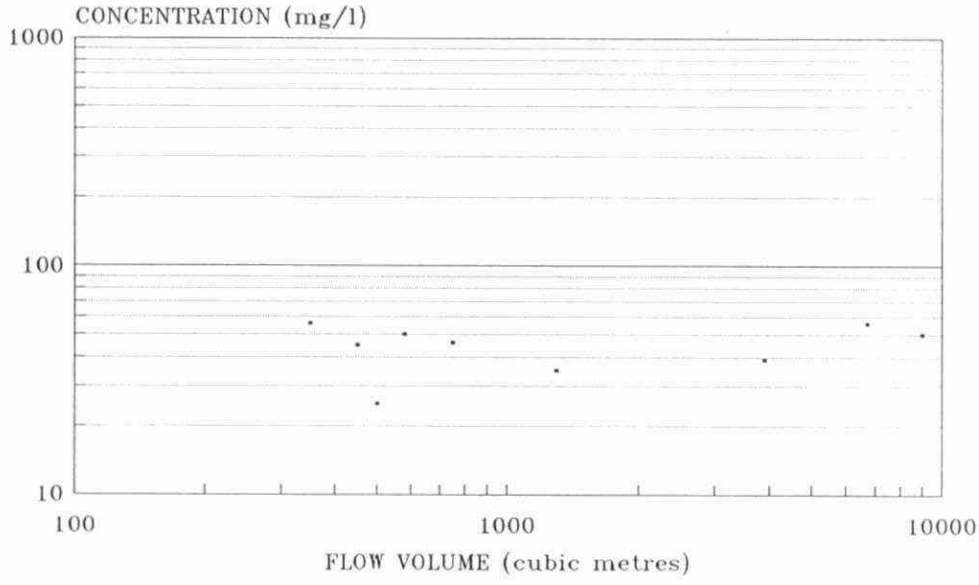
Calculations of contaminant loadings from wet weather concentration and volume data, one should consider for the correlation between the monitored Event Mean Concentration (EMC) and the event runoff volume. Should a relationship exist, a procedure for calculating loadings which takes into account this relationship, is required. Current studies indicate that runoff data for urban residential sites do not show such a relationship, see Figure 6.2. For industrial sites, there is insufficient data to reach a similar conclusion.

FIGURE 6.2

RANGE OF TSS EMC'S BY DRAINAGE AREA



CONCENTRATION – FLOW RELATIONSHIP



EXAMPLE CONCENTRATION ANALYSES

6.6 Calculating Discharge Volumes and Flow Rates

For all drainage areas requiring detailed site investigation and analysis, the stormwater runoff volume and peak flow rate must be calculated to:

- quantify mass loadings;
- assess which drainage areas contribute the greatest quantities of runoff, for they may be the cause for the highest contaminant loading; and
- design structural BMP controls.

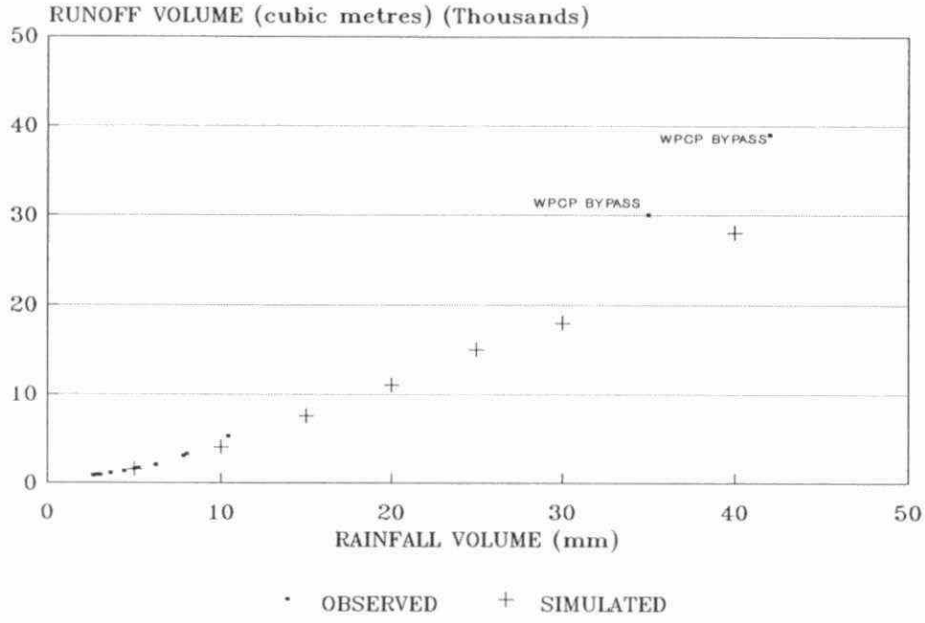
Calculation or estimation of runoff volume is required to quantify mass loadings, compare the relative quantities of runoff from each drainage area and design storage requirement for retention or detention type structural BMPs. Flow measurement may be directly used to provide the required runoff volumes for analysis or they may be used to establish a relationship between rainfall and runoff volume.

The rainfall–runoff relationship can be used to predict or estimate volumes for future runoff events and the design of structural BMPs for various levels of protection. The relationship can be established graphically or by statistical methods, see Figure 6.3. Typically, the relationship is established to identify runoff volumes for 5, 10, 15, 20 and 25 mm rainfall events. Current Ministry guidelines suggest controlling stormwater runoff from residential areas for the first 13 to 25 mm of rainfall. These event volumes are typically used as they represent the majority of annual rainfall events in Ontario (in Toronto 90 percent of annual rainfall events are less than 15 mm) which contribute to stormwater runoff.

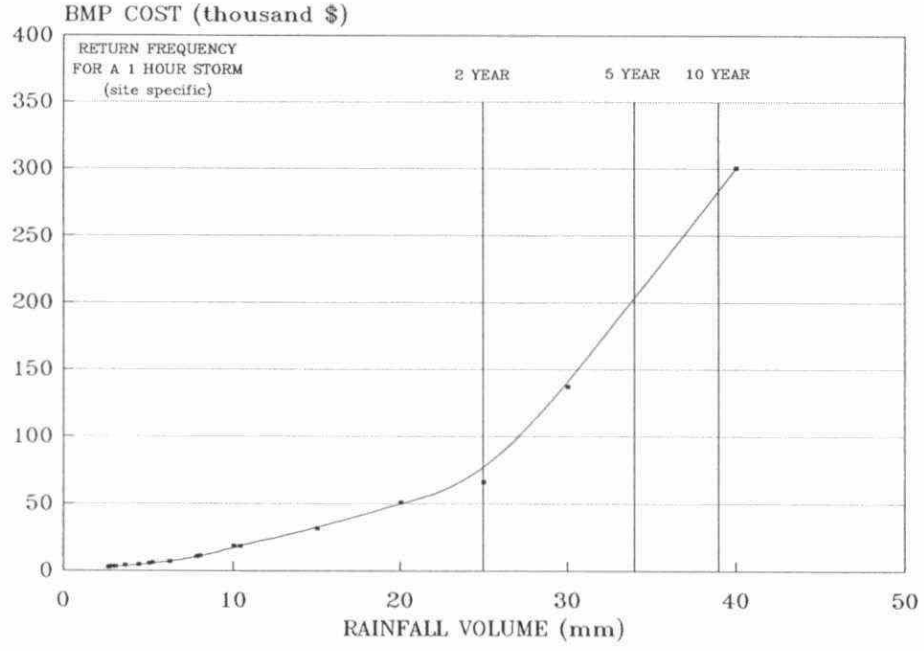
As a minimum, runoff volumes and flow rates should be calculated for 25 mm events. The discharger may wish to assess larger runoff events (greater than 25 mm) as the potential contaminant loads could be much greater than those for residential land uses and it allows the discharger to perform a cost benefit analysis with more infrequent storms.

FIGURE 6.3

RAINFALL–RUNOFF RELATIONSHIP



BMP COST BY RAINFALL EVENT SIZE



EXAMPLE RAINFALL–RUNOFF–COST ANALYSIS

The peak runoff rate for different rainfall events are required for the design of structural BMPs. Peak flow rates from sewer system outlets may also be obtained from monitored data or calculated using alternative evaluation methods.

For many SWCS, it will not be feasible or practical to monitor stormwater runoff rates and volumes from all effluent streams and for all sizes and duration of rainfall. There are alternative methods available for obtaining stormwater runoff data in such situations. Presented below are basic and detailed methods of calculating runoff flow rates and runoff volumes using monitored data and current engineering practices.

The Rational Method may be used to calculate runoff peak flow. This method is well documented in many engineering handbooks and requires a minimal amount of input information. This method is commonly used for the design of drainage and sewerage systems.

The primary input parameters are the drainage area, peak rainfall intensity and the runoff coefficient. The drainage area will have been obtained from the previous site mapping task. The runoff coefficient may be determined from monitored runoff events or can be obtained from handbooks for the land use and runoff surfaces identified in the mapping task. The peak rainfall intensity is a function of the runoff time of concentration and the desired design rainfall return frequency. The Rational Method is generally limited to rainfall events with a 2 to 5 year return frequency. A 1–hour 2 year AES design storm is typically adequate for the design of BMPs as this event accounts for most events responsible for the washoff of accumulated surface contaminants and meets the minimum hydraulic design for most drainage works (sewers and ditches). Calculating flows for larger events may be useful for cost–benefit analyses (see Figure 6.3).

Runoff volumes may be calculated using a similar method by multiplying the drainage area by the rainfall depth and a volumetric runoff coefficient. Volumetric runoff coefficients can be determined from monitored events.

The above two methods are well–suited for industrial sites with a high percent of impervious land and can be developed efficiently into spreadsheet type models. There will be some plant sites or drainage areas where the above methods may not be adequate or suitable, in which case more detail analysis will be required.

Characteristics which may require the need for detailed analyses include drainage areas with:

- a high degree of pervious land;
- variable soil conditions or types;
- variable site topography;
- large external drainage areas;
- sewers which surcharge frequently;
- sites which experience frequent flooding from constructed or natural drainage systems; and
- drainage systems with stormwater storage and/or treatment facilities.

Computer simulation models are typically used for analyzing these types of drainage systems. Modelling of runoff processes may be required on an event and/or continuous basis.

Event type modelling is typically used for analyzing specific historical or design storm events where the hydrology and hydraulics of the drainage systems are relatively independent

of previous events. Areas with a high percent of impervious land with no storage, retention or detention type facilities are suitable for event simulation analysis.

Continuous simulation models account for the hydrologic and hydraulic characteristics of a drainage area over a series of real or historical rainfall events and interevent dry periods. The time period for analysis could be 1 typical year of rainfall or 20 years of rainfall. These types of models are particularly useful for analyzing the performance of existing or proposed treatment facilities as they become subjected to the variability of rainfall conditions and the watershed runoff response.

Computer models require considerably more input data in order to simulate complex processes. The models also require calibration and validation to ensure their credibility.

Some of the more commonly used computer programs in Ontario include:

- USEPA Stormwater Management Model (SWMM) – Runoff, Extran, Transport, Rainfall and Storage Treatment Blocks;
- Storage Treatment Overflow Runoff Model (STORM);
- Microcomputer Interactive Design of Urban Stormwater Systems (MIDUSS); and
- Ottawa Hydrologic Model (OTTHYMO).

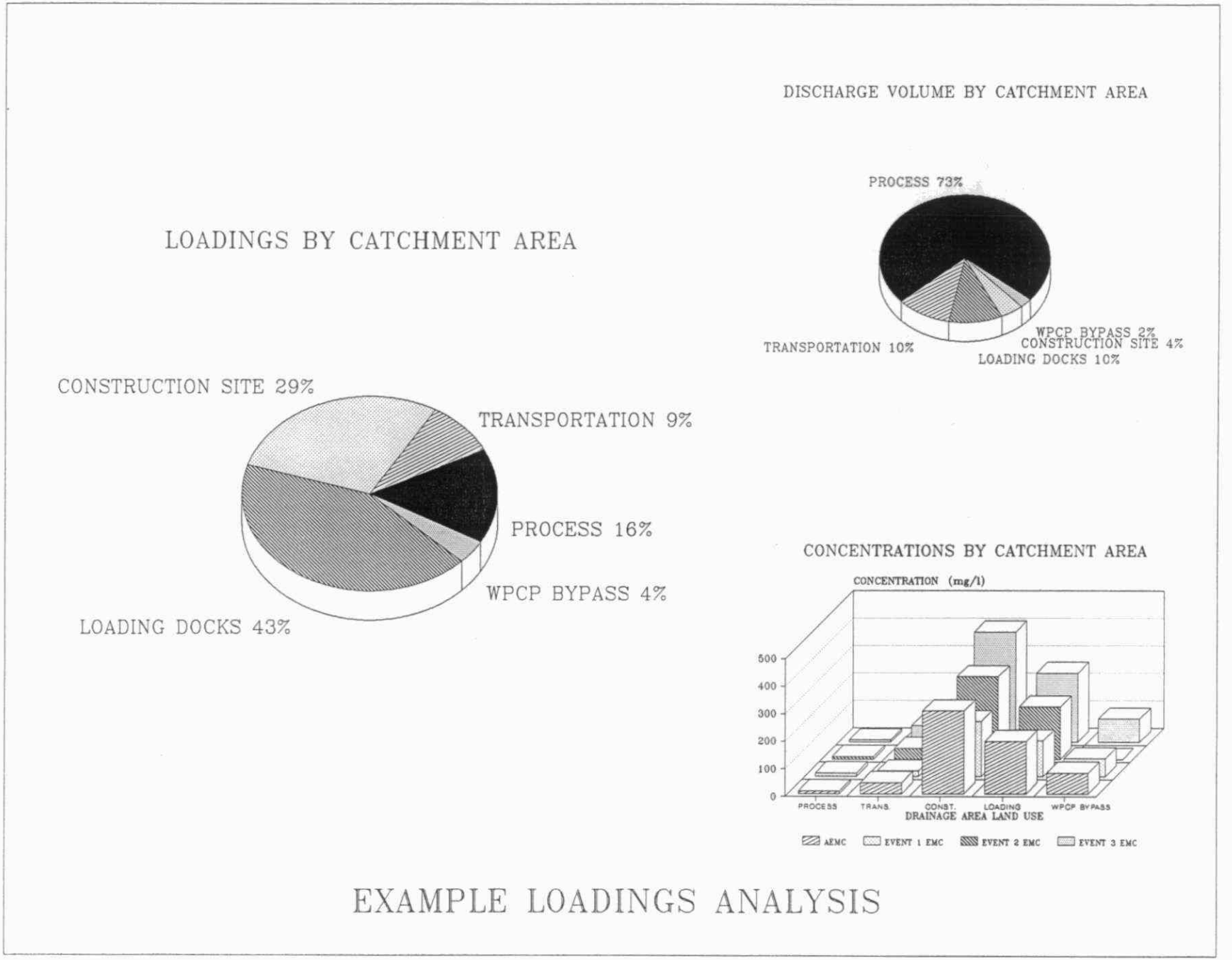
Each of the above programs have their own unique features, requirements and limitations. It is particularly important to assess the real need for such models for an industrial site. For most sites, the more simplified approach using the rational method and spreadsheet type models will do; however, if detailed modelling is considered necessary, the correct program should be selected.

6.7 Calculation of Discharge Mass Loadings

Contaminants discharged to receiving water have the potential for creating both acute or chronic toxicity problems. One method of controlling chronic problems is to control the total mass loading of the contaminant.

The mass loading is the product of the AEMC and runoff volume. As discussed in Section 6.6, should a relationship exist between the EMC and the event runoff volume, then a procedure is required which takes into account this relationship.

Mass loading should be calculated on a monthly basis (i.e., units of kg/month) and summarized for each contaminant and catchment investigated. Each catchment should be ranked by the contaminant loading. Explanation should be given why one catchment has a higher loading than another (i.e., is it due to a higher concentration of the contamination or a higher volume of discharge, or both), see Figure 6.4.



EXAMPLE LOADINGS ANALYSIS

FIGURE 6.4

7.0 SELECTION OF CONTROLS AND EVALUATION OF PROTECTION PROVIDED (PHASE III)

The steps to be used in selecting controls and evaluating different levels of protection provided by these controls are given in Figure 7.1. Implementation considerations are described in Chapter 8.

7.1 Overview of Objectives and Approaches to Pollution Prevention and Control

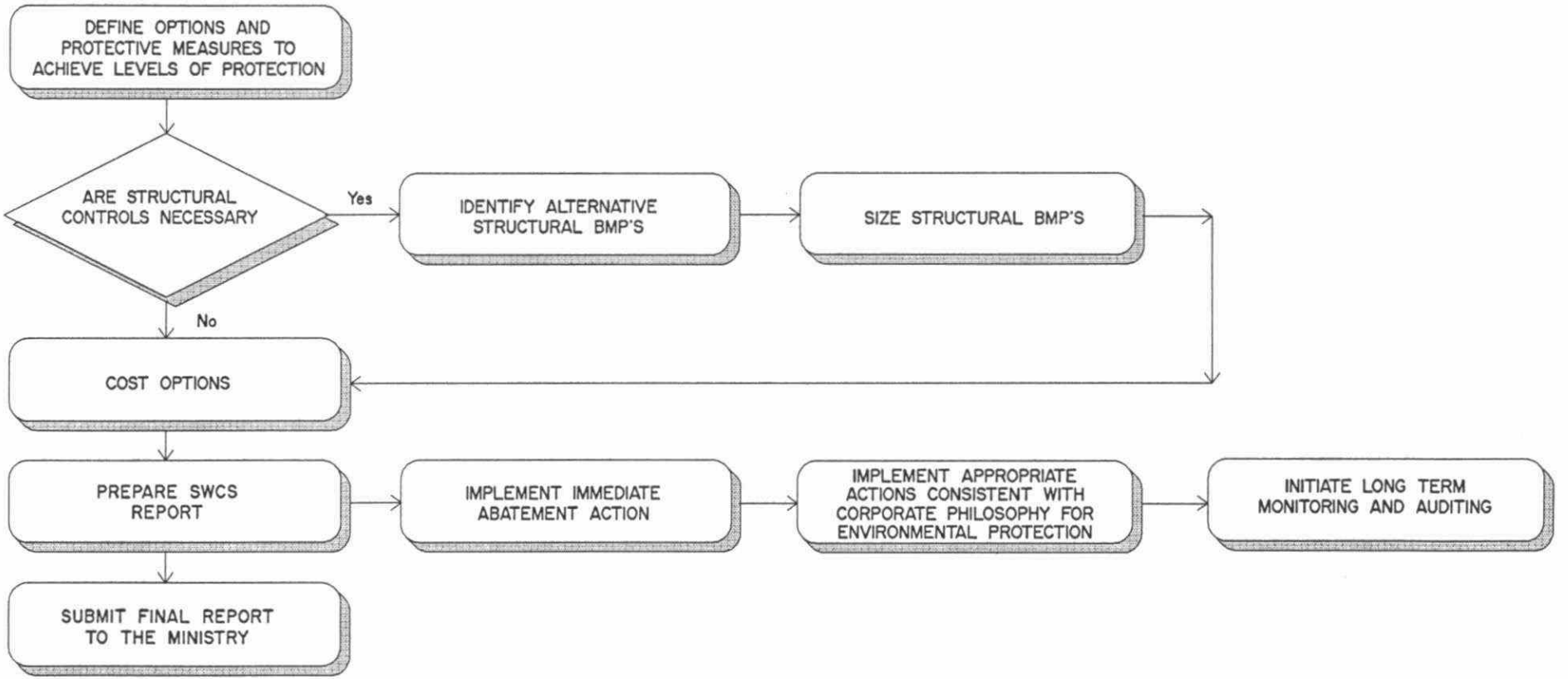
Overview of Objectives

The long term goal of MISA is virtual elimination of all persistent toxic substances from industrial and municipal discharges in Ontario waterways. This will ultimately be achieved through pollution prevention, separation of contaminated and uncontaminated flows, flow reduction, recovery, reuse, recycle and pollution control. Where persistent toxic pollutants cannot be practically or economically reduced to sufficiently low or non-detectable concentrations, at-source modifications will be required, including replacing persistent toxic chemicals with alternative compounds.

Performance objectives may take various forms dependent upon the degree of water quality improvement required. These forms, include:

- meeting the sector BAT criteria for process effluents;
- meeting a minimum treatment level for specific BMP technologies;
- meeting the Model Sewer Use Control By-Laws; and
- having a non-toxic discharge (chronic and acute lethality).

Numeric water quality-based limits, would be stated as a concentration and/or loading limit averaged over a specified number of events, for all or part of the year. The monitoring program incorporated into all SWC plans would be tailored to allow compliance calculations as a minimum requirement.


DEFINE OPTIONS AND PROTECTIVE MEASURES TO ACHIEVE LEVELS OF PROTECTION
ARE STRUCTURAL CONTROLS NECESSARY
Yes
IDENTIFY ALTERNATIVE STRUCTURAL BMP'S
SIZE STRUCTURAL BMP'S
No
COST OPTIONS
PREPARE SWCS REPORT
IMPLEMENT IMMEDIATE ABATEMENT ACTION
IMPLEMENT APPROPRIATE ACTIONS CONSISTENT WITH CORPORATE PHILOSOPHY FOR ENVIRONMENTAL PROTECTION
INITIATE LONG TERM MONITORING AND AUDITING
SUBMIT FINAL REPORT TO THE MINISTRY

DEVELOP SWC PLAN

FIGURE 7.1

The Ministry has chosen not to develop sector–wide effluent limits for stormwater. However it is useful to develop performance objectives for the site as part of the development of the plan, in order to allow the discharger to demonstrate success. Accordingly, a level of protection approach has been adopted for the SWCS. It is described below in Section 7.5.

Basic Approaches to Controlling Contaminants in Stormwater

There are two basic approaches to controlling contaminants in stormwater, pollution prevention and pollution control.

Pollution Prevention is an umbrella term for a wide range of source pollution reduction activities. These may include:

- education, e.g., train industrial professionals in waste and water management;
- source control. e.g., spills prevention and management; and
- alternative substance usage, e.g., replacing hazardous with non–hazardous materials in processes.

Pollution prevention is also referred to as non–structural control or best management practices by some practitioners.

Pollution Control generally involves the construction of a control device to reduce the concentration or impact of contaminants from a given source. A good example is the installation of an oil–water separator.

Non–structural controls are described, in Section 7.2, and structural controls are described in Section 7.3. In most circumstances, a review of both control strategies is necessary in order to develop an optimized stormwater control plan.

7.2 Pollution Prevention

Pollution prevention or non–structural controls generally comprise procedures, methods, or practices associated, but not limited to the activities outlined in Tables 7.1(a) and 7.1(b). These are the major types of non–structural controls conventionally used for stormwater quality control. Measures which can address specific contaminants or classes of contaminants are presented in Table 7.3.

7.3 Structural Controls

Structural controls comprise physical structures/devices/BMPs designed to intercept stormwater and to "treat" the stormwater if it is contaminated. Table 7.2 lists the conventional structures used in stormwater quality control together with contaminants removed, principles of operation, and major considerations together with references. Table 7.3 provides a more detailed summary of potential contaminants in stormwater and various structural controls which may be employed to achieve contaminants reduction, should the need arise to remove specific contaminants.

For the most part, the conventional controls can be further classified according to the following:

- sedimentation and erosion control during on–site construction;
- stormwater ponds (i.e., wet, extended wet and extended dry ponds);

TABLE 7.1(a): LIST OF NON-STRUCTURAL CONTROLS

Control	Description
Raw and Processed Material Storage and Handling	Controls designed to intercept stormwater in and around areas of bulk material storage or where materials are manipulated and spills are most likely to occur. Roof areas or covers to deflect rainwater away from these areas offer some advantages.
Waste Material and Litter	Controls designed to minimize the accumulation and or deposition of debris and trash.
Alternative Collection and Disposal Methods	Controls designed to regulate the discharge from roofs or other catchment areas or the separation of interconnected collection systems.
Reuse/Recycle	Controls which incorporate reuse/recycling of stormwater for industrial purposes. There are conceptual advantages to be gained from this approach but more development is required to make this practical.
Housekeeping	Controls which promote good housekeeping (i.e., spill cleanup, sweeping of process, material handling and parking areas, catchbasin cleaning) are essential to maintain a clean and orderly work environment which contributes to overall contaminant reduction.
Education/Training	Controls based upon employee training are essential if personnel are to understand fundamental procedures for minimizing pollutant loadings.
Preventative Maintenance	Controls to minimize the potential for discharges of contaminated stormwater. For example, regular testing of alarms, inspection, repair and replacement of filters, valves, connections, etc.
Security	A system to prevent accidental or intentional entry to a facility which might result in vandalism, theft, sabotage or other improper or illegal use of the plant facilities, that could cause a surface runoff to storm sewers incident. Measures could include: • routine patrols of plant; • fencing; • good lighting; • traffic control; • guardhouse or gate for controlled access; • visitors passes; • locked entrances; and • locks on drain valves and pump starters.

TABLE 7.1(b): LIST OF NON–STRUCTURAL CONTROLS

Control	Description
BMP Committee for Risk Identification and Assessment	Personnel knowledgeable in plant processes, waste treatment, safety and spill control form committee to: • identify potential sources of stormwater contamination; • establish incident reporting procedures; • develop inspection procedures and record formats; • review incidents; • review new construction plans and changes to processes and procedures; • review training of employees; and • coordinate plant incident response, cleanup and notification of authorities following an incident.
Contingency Planning and Spill Response Capability	Anticipation of potential problems/situations allow for pre–emptive measures to be taken. A little forethought can help to mitigate discharges. Identify and indicate proper use of existing spill response equipment available on–site including personnel protection supplies and equipment. Identify proper disposal of used materials.
Inspections and Record Keeping	These controls provide a tracking procedure to assure that adequate response and corrective actions have been taken.

TABLE 7.2: STRUCTURAL CONTROL OPTIONS FOR INDUSTRIAL SITES

Structural Control Option	Major Contaminants Addressed	Principle(s) of Operation	Major Considerations
Sedimentation tank	Suspended solids Oil and Grease	Gravity separation	Operation and Maintenance Pumping Degritting
Stormwater pond	Suspended solids	Gravity separation Storage	Operation and Maintenance Pumping
Oil/Grit separator	Suspended solids Oil and Grease	Gravity separation	Limiting hydraulic capacity Operation and Maintenance Degritting Oil and Grease Removal
Screening	Suspended particulates Floatables/trash	Screening/straining	Operation and Maintenance
Spills and erosion control	Chemicals, oils, grit, particulates	Containment in control area	At source control
Infiltration techniques	Suspended and dissolved solids/particulates	Percolation into soil.	Not suitable for runoff from process areas.

TABLE 7.3: CAPABILITIES OF STRUCTURAL AND NON-STRUCTURAL CONTROL OPTIONS TO REMOVE SPECIFIC POLLUTANTS

Potential Contaminants	Structural Control Options	Non-Structural Control Options*
pH	Neutralization by pH adjustment/control.	Recycle cooling water
Suspended solids	Screening, sediment, gravity separation, floatation, filtration.	Reuse cooling water as process water
BOD	Chemical and/or biological oxidation.	Recycle process water
Oil/grease	Gravity separation, floatation.	Reuse process water after treatment in less critical in less critical process areas
Dissolved salts	Ultrafiltration.	Recover metal hydroxide sludge–waste exchange
Metals	Precipitation and sedimentation, ion exchange, vacuum evaporation	Restrict chemical use
Cyanides	Chemical oxidation at sources	Improve operator training and awareness
Organics	Chemical and/or biological oxidation, activated carbon, vacuum evaporation.	Improve plant control
Solvents	Biological oxidation, activated carbon, ultrafiltration.	Improve spill control by employees
Alcohols	Biological oxidation.	Improve reporting and recording of spills
Phenols	Chemical and/or biological oxidation.	Reduce waste introduced to process effluent
Ammonia	Stripping.	Identify source(s) of contaminants
Phosphorus	Precipitation.	Increase effluent quality requirements
Bacteria	Disinfection by chlorination/dechlorination or UV disinfection.	Improve housekeeping practices
		Improve storage and material handling

* Non structural control options are potentially applicable to all contaminants. The effectiveness for specific pollutant depends upon the specific source concentration and volume.

- oil/grit separators/tanks;
- spill control (i.e., berms, dykes, containment); and
- diversion of stormwater around contaminated areas.

The effectiveness of several of these technologies is not well-documented and may need a dynamic implementation plan (install, monitor and modify as necessary) to reach a specific level of protection.

7.4 Selecting the Best Control(s)

Each discharger will develop prevention and control strategies designed to mitigate site-specific stormwater control problems to meet each level of protection outlined in the next section. This will generally involve the use of both non-structural and structural controls.

The BMPs should be selected using a two-step screening process whereby a list of control options may be screened to generate a short list. The two-step screening process would involve:

- generating the long list of options;
- deciding whether each option is highly applicable, partially applicable or not applicable;
- prioritizing these options into a short-list to be considered for detailed performance assessment;
- infiltration techniques (i.e., trenches, ditches, basins); **these techniques are not to be used for outdoor process areas;**

- detailing performance assessment; and
- selecting the list of options needed to provide the levels of protection described below in Section 7.5.

For screening a long list of controls, it is recommended that they be compared using the preliminary criteria described in Table 7.4.

These include:

- Water Quality and Quantity Benefits;
- Technical Feasibility;
- Operation and Maintenance Concerns;
- Estimated Cost–effectiveness;
- Proven Performance;
- Environmental Considerations (Impact During Construction and over the long term);
- Social Considerations: Impact Upon Adjacent Property Owners; and
- Other Benefits.

The control options required to achieve the different levels of protection should be determined using the final screening criteria described in Table 7.5. Clear and concise statements should be used to describe the type and principles of control for the selected options, the problems they solve, the associated costs, benefits and expected time frame for implementation.

TABLE 7.4: PRELIMINARY SCREENING OF CONTROL OPTIONS

Criteria	Description
Water Quality and Quantity Benefits	Assess relative improvements in reducing loadings and occurrences of non–compliance. Computer modelling, particularly for large sites, is useful for this analysis.
Technical Feasibility	Determine if existing site constraints or operations limit implementation of selection option.
Operation and Maintenance Consideration	Determine whether the procedure is practical; evaluate its impact upon plant operation and maintenance schedules; assess whether plant staff need additional training
Estimated Cost–Effectiveness	Develop a cost–effective analysis to screen options which provide comparable performance and meet performance objectives.
Proven Performance	Evaluate suitability of the control options based on its demonstrated or proven performance under specified operating conditions and any applicable operation and maintenance concerns or constraints.
Environmental Considerations	Assess the impacts of implementing the selecting option in terms of relevant environmental impacts. This process should attempt to quantify both positive and negative environmental impacts resulting from the control option. Source controls are likely to have less impact than end of pipe controls.
Social Considerations	Quantify the impacts of the control option upon the local community and adjacent property owners where applicable.
Other Benefits	Assess tangible and intangible benefits.

TABLE 7.5: FINAL SCREENING OF CONTROL OPTIONS

Criteria	Description
General Requirements	Itemize important advantages and disadvantages.
Design	Evaluate hydraulic limitation and effluent sampling/flow monitoring requirements.
Costs	Develop detailed assessment of capital, operating and maintenance costs.
Plant Operation	Identify those areas handled by the selected control and any impact on other plant operations (i.e., will a plant shutdown be required for construction/maintenance activities).
Schedule	Define the time frame for remedial stages if applicable.
Regulatory	Identify potential risk and legal liability with respect to current and future regulatory considerations.

7.5 Levels of Protection

The intent of examining different levels of protection is to provide targets of increasing degrees of water quality improvement (protection) which the industrial site could attempt to achieve. The levels of protection approach has been adopted because the level of water quality to be established at industrial sites has not been determined. As noted above, it is not clear whether or not:

- stormwater quantity will be regulated;
- technology–based approaches might be applied for specific contaminants in stormwater; or
- water quality–based approaches might be used.

The levels of protection may be used in one of several manners in the future. They may be:

- used by plant staff to establish a prioritized set of control options;
- used by corporate management internally to determine the level of protection that they desire to see established over the long–term as retrofitting opportunities arise, in order to achieve goals consistent with their sense of environmental responsibility;
- used by specific MOE regions to address specific local concerns; and
- used by the MOE to undertake a province–wide assessment of the costs of remediation of stormwater for different levels of water quality. As well, the MOE might discuss these costs and practical implementation aspects with industry as a part of the on–going process of policy development.

The levels of protection are presented in Table 7.6. The possible control measures, water quality concentrations, and SWC activities associated with each level of protection are also summarized in the table. Water quality parameters that are relevant to the different levels of protection are listed in Tables 7.7 and 7.8. All information in these tables is presented as guidance only. The information is not all encompassing since each discharger will need to address site-specific issues, such as those suggested by Table 7.9.

7.5.1 Description of Levels of Protection

The levels of water quality and the probable levels of protection that each will provide are now described. The levels are summarized in Table 7.6.

Level 1: Meet Sector BAT Criteria for Process Effluents

This level would meet sector regulations with respect to the following.

- for the specifically regulated list of contaminants, 8 events out of 10;
- no visible oil sheens or trash on the surface of stormwater;
- the stormwater discharges would not be acutely lethal, 8 events out of 10; and
- sediment settling in the outfall zone below the stormwater outlets will not be toxic.

In addition, the SWC plan should show how the principles of recycling and reuse of water, including stormwater, have been adopted for the site.

TABLE 7.6: BASIC LEVELS OF PROTECTION FOR STORMWATER QUALITY

Description of Level of Protection and Examples of Technical Conditions	Action Required in SWCS
1. Stormwater meets sector BAT criteria for process effluent: • chemical levels specified by BAT limits (8 events out of 10); • non-acutely lethal stormwater discharges (8 events out of 10); • principles of recycling/reusing of stormwater as well as process/cooling water are used where possible; and • no visible oil sheens or trash on the surface of stormwater. This may require that sewer systems (process, cooling water, stormwater) be completely separated or treatment of non-separate sewer system.	• monitoring and site inspection; • define remedial actions and cost; and • implement those readily implementable actions.
2. Improvement of water quality in all stormwater runoff using BMP technologies: • structural BMP devices on all stormwater outlets – this would ensure catching floatables, removal of oil and grease and suspended solids and reduce the potential impact of metals and SOCs attached to settling suspended solids or sediment quality in the receiving water sediment.	• monitoring and site inspection; • define BMPs necessary to provide protection for all stormwater up to the design event; • minimum requirements for detention basins are 24 hours retention for the first 25 mm of rainfall runoff in a 24 hour period; • cost out plan; and • implement BMPs easily implementable and/or consistent with corporate philosophy of environmental protection.
3. Meet Ministry Model Sewer Use Control By-Laws: • stormwater runoff meets Ministry Model Sewer Use Control By-Laws for all substances for most events (8 out of 10).	• monitoring and site inspections; and • define BMP trains necessary to achieve these concentrations.
4. Higher level toxicity concerns: • stormwater discharge passes non-chronic lethality test; and • sediments adjoining stormwater discharge point meet sediment quality threshold levels for open lake disposal of sediments.	• monitoring and site inspections; • define structural and non-structural BMPs necessary to achieve targets; • cost out plan; and • implement readily implementable aspects.

TABLE 7.7(a): WATER QUALITY AND BIOLOGICAL TESTS RELEVANT TO LEVELS OF PROTECTION TABLE

1. To meet sector criteria:

   - Chemical parameters specified in sector regulation;
   - Degree of toxicity can be checked by measuring the principle components of toxicity (see Table 7.8). Generally, these include measuring the following parameters:
     - conducting toxicity test with appropriate organism (e.g., rainbow trout),
     - ammonia,
     - pH,
     - soluble copper,
     - soluble zinc,
     - soluble nickel,
     - Phenols,
     - Total Residual Chlorine,
     - Pentachlorophenol,
     - weak acid dissociable,
     - cyanide (relevant to mines), and
     - As.

2. Parameters to describe aesthetic improvements:

   - Colour;
   - Turbidity;
   - Oil and Grease/Solvent Extractable;
   - BOD or COD;
   - No visible oil sheens or trash on water surface;
   - No visible oily scums sorbed to sides of sewer; and
   - total phosphorus and other nutrients if attached algae grow on side of sewer pipe in summer time.

3. Parameters to describe higher toxicity concerns:

   - Chronic toxicity – measure EC50, NOEC or LOEC levels using standard test (e.g., *Daphnia magna*).
   - Compare sediment quality criteria to sediment contaminant levels. Relevant parameters and levels are given in Table 7.8. Parameters to be measured include:
     - TOC (%),
     - TP,
     - TKN,
     - Oil and Grease (%),

TABLE 7.7(b): WATER QUALITY AND BIOLOGICAL TESTS RELEVANT TO LEVELS OF PROTECTION TABLE

3. Parameters to describe higher toxicity concerns (Cont'd):

   - As,
   - Cd,
   - Pb,
   - Hg,
   - Zn, and
   - PCB.

4. Parameters relevant to Water Quality Based Criteria, dependent upon uses of surface water

   - parameters tested in 2. and 3. above;
   - additional water quality parameters:
     - fecal coliforms (if water has a recreation/swimming use),
     - *E. coli* (if water has a recreation/swimming use),
     - temperature (if discharge is to cold water fishery),
     - mercury (fish flesh quality), and
     - PCBs (fish flesh quality);
   - benthic community – measure benthic community as indicated in Table 7.8; and
   - Sediment Quality Criteria – see levels and parameters given in 3. above.

NOEC = No-Observed-Effect Concentration.
LOEC = Lowest-Observed-Effect-Concentration.
EC50 = Concentration causing 50% inhibition of a sub-lethal response to exposed organisms.

TABLE 7.8(a): METHOD FOR IDENTIFYING CAUSES OF WATER OR SEDIMENT TOXICITY

1. Toxicity components in a water matrix:

   - Toxicity in stormwater can be identified by comparing chemical composition from at least two stormwater samples; and

   - Probable parameters and chemical concentrations (for rainbow trout):

Parameter (mg/L)	Acutely Lethal Level (NOEC)*	Chronic Level (NOEC)*
unionized ammonia or total ammonia (pH)	.045 .045 (6)	.007 .007 (6)
soluble copper	.0195	.007
soluble zinc	0.9	0.03
soluble nickel	2.33	0.42
Phenols	1	0.02
Total Residual Chlorine	0.04	--
Pentachlorophenol	18.8	12
weak acid dissolved cyanide (relevant to mines) As		

2. Parameters to describe higher toxicity concerns:

   - Chronic toxicity can be identified by comparing chemical components in at least two stormwater samples with levels given above (using rainbow trout as test organism) where estimates are based upon EC50 levels and appropriate adjustment factors.

TABLE 7.8(b): METHOD FOR IDENTIFYING CAUSES OF WATER OR SEDIMENT TOXICITY

3. Sediment quality criteria:

- Compare sediment quality criteria to sediment contaminant levels. Relevant parameters and levels include:

Parameter	Suggested Open Water Disposal Criteria Quality	LOEC Levels
TOC (%)	1%	1%
TP	1,000	600
TKN	2,000	550
Oil and Grease (%)	1,500	--
As	8.0	6.0
Cd	1.0	0.6
Pb	50	--
Hg	0.3	0.2
Zn	100	100
PCB	0.07	0.07

TABLE 7.9: SITE SPECIFIC ISSUES

1. What contaminants are in rain water and at what levels?
2. What site activities (raw material handling; leaching from roofs; emission from air pollution control equipment) come in contact with rain water?
3. What grassed areas, treed areas, parking lots come in contact with rainwater?
4. What industrial uses of water (process water, cooling water, sewage) come in contact with stormwater?
5. What contaminants are introduced into stormwater at each of these contact points?
6. What contaminants can be readily minimized by preventing rainwater from contacting certain site activities?
7. What contaminants can be readily removed with simple changes in housekeeping, raw materials handling practices or structural BMPs?
8. What contaminants require sophisticated technologies to remove them and what are their costs?

Level 2: Treatment of all Stormwater Discharges Using BMP Technologies

The intent of this level of improvement is to install structural BMP devices which will control the discharge from every stormwater outlet. For many areas, such as parking lots etc., runoff may meet sector requirements without any control works.

Possible measures could include:

- sedimentation for a twenty–four (24) hour retention period for the runoff produced by twenty–five (25) millimetres of rainfall in a twenty–four (24) hour period;
- an oil/water separator, or grit (sedimentation) chamber on every stormwater outfall; and
- complete sewer separation of rainfall collection systems from process and/or cooling water pipes.

The second and third measures would also trap sediments.

Level 3: Meet Ministry Model Sewer Use Control By–Laws

This level of protection would involve meeting Ministry Model Sewer Use Control By–Laws from stormwater for most events (8 out of 10).

The required SWC activity is to monitor stormwater discharge to define the degree of improvements needed and suggest the BMPs necessary to meet Ministry Model Sewer Use Control By–Laws.

Level 4: Higher Level Toxicity Concerns

This level may involve installing structural devices and instigating non-structural BMPs necessary for ensuring that stormwater passes the sublethal toxicity test for rainbow trout (or other organisms if so designated by the MOE), in 8 out of 10 stormwater events. Alternatively one would carry out toxicity reduction evaluative studies (e.g., see to define sources of contamination which are candidates for pollution prevention efforts. This level of protection would ensure that resident fish populations in rivers that receive a large portion of flow from urban areas, would not suffer from chronic effects of chemical contaminants, if this level of protection is applied to stormwater from both industrial sites and urban areas.

7.5.2 Technical Requirements for SWC with Respect to the Level of Protection

The SWCS report is to document the BMPs necessary to meet all four levels of protection and to provide cost estimates for each level.

8.0 IMPLEMENTATION PLAN (PHASE IV)

An implementation plan should be developed as a part of the SWCS. It should include statements on the following:

- protection and control measures for achieving various levels of protection;
- scheduling and costs;
- discharge monitoring and auditing plan;
- future reporting; and
- future contingency plan.

8.1 Scheduling Elements of the SWCS Plan

The following is a suggested schedule for carrying out phases of the study, and implementation.

Item	Timing
• Sectoral Effluent Limits Regulation issued. Discharger required to carry out SWCS identified.	Day 1
• Discharger shall submit a notice to apply for exemption.	3 Months
• Dischargers shall submit an exemption request or inform the Ministry of their proceeding with the SWCS.	6 Months
• Initiate action on urgent abatement issues.	Immediately

Item	Timing
• Proceed with detailed assessment.	Immediately
• Final Report submitted to the Ministry.	4 Years

This schedule is the maximum time allowed.

8.2 Budgeting and Implementation Planning Within the Company

Cost estimates for all structural and non-structural measures will be made at the time of preparation of Final Report for the SWCS. Drawings for any proposed structural measures should be adequate to estimate costs to ±15%.

This information could be used to prepare internal company documentation outlining budget requirements and justification for the control works. This documentation could be submitted to appropriate internal company authorities to obtain the necessary budget and approvals for the implementation of the stormwater control plan.

It is foreseen that this internal company document could be used exclusively for internal purposes and would not be a part of the stormwater control plan documentation submitted for review by appropriate government authorities.

8.3 Monitoring Plan

A monitoring plan should be developed and included as part of the Implementation Plan. It should define:

- proposed location for flow and water quality measurements;

- proposed parameter list;
- schedule for monitoring during Year 1, Year 2, Year 3, Year 4 and Year 5 after completion of the plan; and
- Reporting frequency, contents and format.

8.5 Contingency Planning

As a part of other ongoing company planning, various contingency plans may be already in place, dependent upon the industrial sector. These include:

- Spills Contingency Plan;
- Hazardous Substance Handling and Management Plan; and
- Abandonment and Restoration Plan.

The relationships of these plans to the SWCS plan should be acknowledged and used to assist implementation of the SWCS, where possible.

9.0 STANDARDS FOR THE STORMWATER CONTROL STUDY REPORT

This section of the technical guidelines describes the minimum report standards which must be complied with in order to be adequate for Ministry use. Report Standards are defined as "the basic information needed in a report to assure that the problem has been defined and the appropriate remediation determined". Study standards are different from the "technical guidelines" presented in Chapters 5 to 7 of the report which describe the technical methodologies for carrying out the stormwater control study.

9.1 Report Format

A suggested table of contents for a SWCS report is presented in Table 9.1. A checklist for ensuring that key questions are addressed is given in Table 9.2.

These tables should be used to organize the study report.

9.2 Minimum Contents of the SWCS Report

At plant sites where monitoring of all outlets is needed to define sources of contamination and/or the plant site is relatively complex, all significant items in Table 9.1 and 9.2 are to be addressed.

TABLE 9.1(a): SUGGESTED TABLE OF CONTENTS FOR SWCS REPORT (Suggested Section lengths are given in brackets)

0 Executive Summary (3 pages)
- 0.1 Definition of Problem
- 0.2 Proposed SWCS Plan

1.0 Introduction (3 pages)
- 1.1 Role of MISA
- 1.2 Company Status in MISA program (contact, non contact water; stormwater)
- 1.3 Levels of Protection for Company Stormwater Control Plan
- 1.4 Administration of SWCS Plan

2.0 Site Characteristics and Screening Study Results (4–8 pages)
- 2.1 Site Mapping and Water Flow Network
- 2.2 Site Inspection to Define Potential Sources of Contaminant Entry into Stormwater
- 2.3 Summary of Existing Flow and Chemical data
- 2.4 Summary of Existing Treatment Systems and BMPs (if they exist for process water or non–contact water)

3.0 Detailed Assessment (If Required; 5–15 pages)
- 3.1 Chemical Monitoring Summary for Events and Dry Weather Flow
- 3.2 Flow Monitoring Summary
- 3.3 Rainfall Data Summary
- 3.4 Detailed Assessment of Condition of Sewer and Other Infrastructure
- 3.5 Data Analysis and/or Modelling
- 3.6 Quality Assurance Program
- 3.7 Statement of Levels of Protection
- 3.8 Screening Assessment of Structural and Non Structural Controls
  - 3.8.1 Sewer Separation
  - 3.8.2 Non Structural Controls
  - 3.8.3 Structural Controls
  - 3.8.4 Linkage of Structural Controls to Existing Treatment System
- 3.9 Statement of Recommended Plans

TABLE 9.1(b): SUGGESTED TABLE OF CONTENTS FOR SWCS REPORT (Suggested Section lengths are given in brackets)

4.0 Implementation Plan (4–7 pages)

- 4.1 Proposed Implementation Plan Schedule
  - 4.1.1 Aspects Already Implemented
- 4.2 Targeted Levels of Protection
- 4.3 Monitoring and Auditing Plan
  - 4.3.1 Inspection of Non Structural BMPs
  - 4.3.2 Flow and Chemical Monitoring
  - 4.3.3 Monitoring Schedule
- 4.4 Reporting Schedule
- 4.5 Contingency Plan

5.0 Conclusions (2 pages)

Glossary of Terms

Appendices

Appendix 1 Correspondence with the Ministry

Appendix 2 Flow Monitoring Data Summaries (if applicable)

Appendix 3 Chemical Monitoring Data Summaries (if applicable)

TABLE 9.2(a): CHECKLIST OF KEY QUESTIONS (Related to Table 9.1)

1.0 Introduction

- state levels of protection examined; and
- state administrative role of the Ministry and the company in SWCS Plan.

2.0 Site Characteristics and Screening Study Results

- define all stormwater outlets and receiving water;
- identify all potential sources of contamination and types of contamination in stormwater based upon existing records and site inspection of raw material and product handling areas;
- identify linkages (if any) with existing treatment systems;
- identify areas of high priority (e.g., spill prone areas);
- determine if additional detailed studies are required, or whether existing information is sufficient to develop a SWCS plan (Note: as a minimum, the company needs to have existing chemical data for stormwater outlets characteristic of the different plant areas – process; parking lots; storage; unloading should be sufficient to define the contaminants found in stormwater runoff. If the data are insufficient, the more detailed assessment is required; and

3.0 Detailed Assessment

- do all stormwater outlets meet a non–toxic criteria;
- have outlets from representative catchments been measured for all potential contaminants of concern (oil and grease, suspended solids; nutrients; metals; synthetic organic compounds);
- have flow volumes during events and baseflow been adequately established; and
- have the appropriate control systems been screened and used to established a train of controls to meet the levels of protection. The relevant control trains include sewer separation, structural and non structural BMPs.

4.0 Implementation Plan

- statement of scheduling and costs;
- statement of achieving various levels of protection;

TABLE 9.2(b): CHECKLIST OF KEY QUESTIONS (Related to Table 9.1)

4.0 Implementation Plan (Cont'd)

- statement of discharge monitoring and auditing plan;
- statement of future reporting; and
- statement of future contingency plan.

5.0 Other Salient Points

- Glossary of Terms;
- QA/QC procedures for flow and chemical concentration aspects;
- summary of computer code selection, and calculation procedures (if code was used in the analysis);
- show that proposed SWCS plan is consistent with MISA objectives; and
- ensure that cost estimates and justifications have been prepared and submitted internally within Company Budgeting process at the time of submittal of SWCS plan to the Ministry.

10.0 GLOSSARY

Acute lethality	A stimulus or effect causing death directly.
AEMC	Arithmetic mean of samples representing the event mean concentration.
AES	The Atmospheric Environment Service Branch of Environment Canada.
BATEA	Best Available Technology Economically Achievable. BAT may include: changes in production processes, chemical substitution, in-plant controls, best management practices, water conservation, effluent treatment technologies; or energy conservation.
Benthic Community	Organisms which inhabit aquatic sediments.
Berm	A strip of earth, concrete or other material surrounding an area to contain stormwater runoff or surface spill.
BMP	Best Management Practice, a structural or non structure practice used to prevent or control the contamination of stormwater runoff.
BOD	Biochemical oxygen demand, means carbonaceous oxygen demand (biochemical) as determined by Standard Methods when an inhibitating chemical has been added to prevent ammonia oxidation.
Bypass	The diversion of untreated or partially treated process effluent that results in the discharge of effluent from any part of a process effluent collection system or treatment process directly to a surface water.

Certificate of Approval	A Ministry of the Environment approval certificate for the operation of treatment works.
Chezy–Mannning	A widely used formula used to compute uniform–Formula flow rates for open channel flow.
Chronic lethality	A stimulus below the level which cause death.
Class EA	Class Environmental Assessment. A planning process used for a group of projects which are relatively small in scale, recur frequently, have a generally predictable range of effects and have relatively minor environmental significance.
COD	Chemical oxygen demand. A measure of the oxygen required to oxidize susceptible organic matter and inorganic compounds under vigorous chemical oxidation conditions.
Composite sample	A sample which is composed of a series of grab samples taken at intervals during the sampling period.
Control Order	A Ministry of the Environment procedure for prescribing results desired on part of an industry.
Design storm	A specific amount of storm rainfall, with its areal and temporal distribution, used to estimate a design discharge.
Direct Discharger	An owner or person in occupation or having the charge, management or control of a plant that discharges effluent directly to a surface water.

DOC	Dissolved organ carbon. A measure of the dissolved inorganic and organic carbon in a water sample.
EC50	Effective Concentration of a test material that causes death to 50 percent of a population within a given time period.
Effluent	The flow of treated or contaminated discharge from a drainage system.
EMC	Event Mean Concentration, the concentration of a specific contaminant analyzed for in a sampled (grab or composite) which represent the quality of stormwater runoff or effluent sampled.
ESR	Environmental Study Report. Refers to the document for a specific project which illustrates the planning and decision making process which has been followed and the mitigating measures which will be taken to ensure that the Environmental Assessment Act has been adhered to.
Evapo–transpiration	A term used to describe the total water removed from an area by transpiration and evaporation from soil, snow and water surfaces.
FC	Fecal Coliform bacteria, a sub group of the Total coliform. A common test used as an indicator of relatively recent fecal pollution inputs, however, it is by no means completely selective for Escherichia coli, the coliform most directly related to fecal pollution.
Flow proportional	A single sample intended to provide the composite sample average water quality (EMC) for the entire runoff event. The sample accounts for the variation in flow by collecting an aliquot of flow proportional to the rate of flow.

Fluorometer	A device used for measuring flow based on determining the degree of dilution of an added tracer solution in flowing water.
Grab sample	An aliquot of the flow being sampled taken at one particular time and place.
Hydraulic radius	A term used when calculating flow rate. The ratio of the water area to its wetted perimeter.
Hydrograph	A graph of flow rate (or sometimes stage) versus time at a given point on a stream or sewer.
IDF curve	Intensity–Duration–Frequency curve. Curves expressing rainfall intensities for specific durations and frequencies at a given climatological station. Data may also be presented in the form of tables or maps.
Impervious	A term applied to a material through which water cannot pass or through which water passes with great difficulty .
Indirect discharger	An owner or person in occupation or having the charge, management or control of a plant that does not discharge effluent directly to a surface water.
Infiltration	(1) The entering of water through the interstices or pores of a soil or other porous medium. (2) The quantity of ground water which leaks into a sewer system or drain through defective joints. (3) The entrance of water from the ground into a sewer or drain through breaks, defective joints, or porous walls. (4) Absorbtion of liquid water by soil, either as it falls as precipitation or from a stream flowing over the surface.

MISA	Municipal–Industrial Strategy for Abatement. A Province of Ontario program with its goal of "virtual elimination of all persistent toxic contaminants from all discharges into Ontario's waterways".
Oil/grit separator	A treatment system which separates floating oil and debris and heavy solids from flowing water.
Operating day	In relationship to a direct discharger's plant, means a twenty–four hour period specified by the discharger during the whole or some part of which the plant is discharging effluent.
PAH	Polynuclear Aromatic Hydrocarbons. An extensively studied pollutant in air and water. PAH's are formed during the heating, burning, incineration and other combustion processes of many types of carbonaceous materials. They are also associated with coal, oil and gas burning power plants, steel and petrochemical industries.
PCB	Polychlorinated biphenyl. A persistent toxic compound historically used in many industries.
Pervious	A term applied to a material through which water passes relatively freely.
Persistent Toxic Substance	As described by the International Joint Commission Task Force "...all toxic substances with a half–life greater than eight (8) weeks...that cause death, disease, behaviourial abnormalities, cancer, genetic mutations, physiological or reproductive malfunctions or physical deformities in any organism or its offspring."
QA/QC	Quality Assurance and Quality Control. Quality assurance is a management function which rests on the documentation and

	establishment of quality control protocol and the evaluation and summarization of their outcome. Quality control is a technical, operational function which investigates and confirms the proper conduct of all those procedural components necessary to a successful conclusion.
Rational method	A widely used computation procedure to design and analyze flow in storm sewers and ditches.
Return period	The average period of years between occurrences equal to or greater than a given value
Runoff	The portion of precipitation or snow melt on a drainage basin that ultimately reaches a surface water.
Sedimentation tank	An underground facility which separates settleable solids from flowing water.
Surface water	Means a lake, river, pond, stream, reservoir, swamp, marsh or surface drainage works.
Swale	A shallow drainage channel generally of low grade.
TBRG	Tipping bucket rain gauge used to measure rainfall depth duration and intensity.
TP	Total Phosphorus. A measure of all phosphorus combinations.
TRC	Total Residual Chlorine
TSS	Total Suspended Solids.

USEPA	United States Environmental Protection Agency
Virtual elimination	As described by the Internal Joint Commission Task Force on Virtual Elimination "... an overall strategy, focusing on preventative and remedial approaches, to achieve the GLWQA goal of restoring and maintaining ecosystem health....
Volumetric runoff	A coefficient used to express the ratio of coefficientrunoff volume to rainfall volume.
Weir	A common device used to measure flow. A weir, essentially is an obstruction or dam built across an open channel over which water will flow.

NON STORMWATER DISCHARGE INSPECTION METHODS

The presence, extent and sources of NSWD may have a direct or indirect influence on the quality of discharge from storm sewer and surface drainage systems during both dry and wet weather conditions. There are many possible sources and causes for a NSWD including:

- crossed or illicit connections between process or sanitary sewer lines and the storm sewer drainage system;
- spills which flow into catchbasins, floor drains or ditches;
- wash areas for equipment, machinery and vehicles;
- infiltration or seepage of contaminated groundwater;
- discharge from treatment facilities, lagoons or holding ponds;
- improperly dumped or stored materials;
- runoff from lawn watering which may contain nutrients and pesticides; and
- external flow sources.

Observations and test for NSWD generally begin at the furthest downstream location and conducted upstream until their sources ares identified. Some sources may be very diffuse with no specific location for control. In other cases the source can be readily identified and can be controlled through immediate abatement action.

Methods for inspecting Non Stormwater Discharges (NSWD) are outlined below.

Field Observations

Field observations can be obtained during scheduled field inspections or by plant operations staff. Observations of flow, stains, oil sheens, scum, sanitary waste and discoloured water are just some of the indications of a possible NSWD. Observations are best made at locations which are normally dry (i.e. not normally in contact with cooling waters).

Event Recorders

The occurrence and frequency of intermittent discharges is difficult to identify and quantify by basic field observations. Event recorders can be an in expensive and relatively easy method to obtain such information. Examples of a basic event recorders include:

- the placement of objects (coloured balls or ribbons) which will be displaced during a NSWD event;
- the placement of chalk marks which will be removed or discoloured at various depths of flow; and
- the placement of small cups which will retain flow from a NSWD which may have occurred.

More sophisticated methods include the use of timers which are actuated by flow closing an electrical circuit directly or by a float switch. This method provides additional information on the specific time and duration of a NSWD event.

Event recorders can be placed in many locations throughout the storm drainage network. The most common locations include sewer outfalls, ditches, sewer access points and catchbasins.

Water Quality Sampling

If a NSWD is identified it is useful to know its quality to identifying the possible contaminant source and to determine if its discharge presents a pollution problem. Grab samples and twenty–four hour composite samples are the most common methods for sampling NSWD. An automatic sampler actuated by the NSWD may be required for unpredictable, intermittent discharges.

Samples may be used to trace upstream sources of the contamination.

Flow Measurements and Monitoring

Continuous flow monitoring allows for the identification and quantification of intermittent NSWD. Measuring the rate of an observed NSWD is useful for estimating the contaminant loading.

Measuring NSWD flow rates can be very difficult due to their inherent low flow rates and intermittent occurrences. With most monitoring equipment the depth of flow is generally too low for accurate measurements. Low flow depths may be overcome through the use of low check dams in the flow path dow stream of the flow recorder. In many cases visual estimation may be the best method available.

Connectivity Testing

Connectivity testing is used to validate sewer and drainage network plans. This is required to trace, identify and locate the location of NSWD. Connectivity test can be conducted by using a variety of material or methods such as water, dye, smoke and floating objects. There are limitations with each method and as such more than one method may be required to obtained the required information to validate the results of a test by another method.

Water and dye testing are perhaps the simplest methods to test for a possible interconnection which could result in NSWD. By injecting water and or dye into either the storm, process, non contact cooling or sanitary drainage systems they can be searched and traced through the storm drainage network. The use of water alone is most useful at locations which are normally dry. Depending on the location and nature of the interconnectivity there could be a considerable lag in the observation of water or dye. These method are perhaps the most common and is easiest to perform, however they cannot identify all possible interconnections. Interconnections which occur at higher flow conditions could be missed by these methods.

Smoke testing consists of injecting a non-toxic smoke into a sewer access point at a sufficient volume and rate such that it will exit at the possible inlet locations. Smoke testing has the advantage of completely filling the volume of a pipe and identifying interconnections which may occur at any flow depth. Smoke testing is limited by interconnections which may be sealed by a water trap. This traditional method for inspecting sewer networks has been very successful in urban residential areas, however, has its limitation on industrial sites.

Close Circuit Television Inspection (CCTV)

CCTV surveys are very useful for the identification of interconnections which cannot be traced by any of the above methods. It is highly possible that the interconnection will occur upstream of a sewer access point to the storm sewer drainage network thereby making more detailed assessment of the NSWD source difficult. If more accurate and detailed information is required on the nature of the interconnection then CCTV can be used.

CCTV surveys are conducted with mobile systems consisting of a cameras pulled with drag lines through the sewer system, displayed in real time on screen and recorded on video tape. CCTV is frequently used in the inspection of new and old sanitary and storm sewer systems in residential developments.

STORMWATER CONTROL STUDY EXAMPLE

STORMWATER CONTROL STUDY EXAMPLE CATCHMENT AREA ASSESSMENT SUMMARY

	PHASE I EXEMPTION ASSESSMENT				PHASE IIa SCREENING LEVEL STUDY		
ACTION	- REVIEW EXISTING MISA DATA AND SITE INFORMATION - TO DETERMINE EXISTING LEVEL(S) OF PROTECTION - DETERMINE IF APPLICATION FOR AN EXEMPTION IS POSSIBLE				- PREPARE BASEMAPS - COLLECT A MINIMUM OF 3 SAMPLES FOR EACH SITE WITH AN UNKOWN LEVEL OF PROTECTION - FIELD INSPECT ALL DRAINAGE AREAS	- ASSESS EXISTING BMP'S - CATEGORIZE EACH CATCHMENT AREA BY IT'S IDENTIFIED PROBLEMS	
RESULTS	DRAINAGE AREA	LAND USE	MISA MONITORING DATA	EXISTING BMP	EXISTING LEVEL OF PROTECTION	SITE INSPECTION	REVIEW OF QUALITY AND QUANTITY DATA	DRAINAGE AREA CATAGORY
	1	OPEN UNDEVELOPED	NON	LEAVE UNDEVELOPED	UNKNOWN	NO PROBLEMS OBSERVED	3 OF 3 SAMPLES MEET LEVEL 1 CRITERIA	IV
	2	INDOOR PROCESS	NON	SPILL CONTROL PLAN	UNKNOWN	STAINS AROUND DRAINS FROM AN UNKNOWN SOURCE	LC50 TOXICITY TESTS EXCEEDED IN 3 OF 3 SAMPLES	I
	3	OUTDOOR PROCESS	12 SAMPLES	TREATMENT LAGOON	1	NO PROBLEMS OBSERVED	—	IV
	4	RAW MATERIAL STORAGE	12 SAMPLES	CONTAINMENT BERMS	1	LEAKING BERMS	LEVEL 1 CRITERIA EXCEEDED FOR 2 LARGE RAINFALL EVENTS	III & I
	5	LOADING DOCKS	NON	SPILL CONTROL PLAN	UNKNOWN	HIGH SEDIMENT LOAD IN CATCHBASIN SUMPS	HIGH TOTAL SUSPENDED SOLIDS LOADS	I
	6	ADMINISTRATION OFFICES	NON	NON	UNKNOWN	NO PROBLEMS OBSERVED	3 OF 3 SAMPLES MEET LEVEL 1 CRITERIA	IV
	7	CONSTRUCTION SITE	NON	NON	UNKNOWN	NO EROSION AND SEDIMENT CONTROLS	HIGH TOTAL SUSPENDED SOLIDS LOADS	III
	8	FUEL STORAGE	6 SAMPLES	CONTAINMENT BERMS	1	NO PROBLEMS OBSERVED	3 OF 3 SAMPLES MEET LEVEL 1 CRITERIA	IV
	9	FINAL PRODUCT STORAGE	NON	NON	UNKNOWN	NO PROBLEMS OBSERVED	3 OF 3 SAMPLES MEET LEVEL 1 CRITERIA	IV
	10	PARKING LOT	NON	NON	UNKNOWN	OIL IN CATCHBASINS NON STORMWATER DISCHARGE	HIGH OIL AND BACTERIA LOADS FOR 3 OF 3 SAMPLES	I
	11	OUTDOOR WASTE STORAGE	8 SAMPLES	CONTAINMENT BERMS	3	NO PROBLEMS OBSERVED	3 OF 3 SAMPLES MEET LEVEL 3 CRITERIA	IV
	12	WPCP BYPASS	4 SAMPLES	NON	3	BYPASS OBSERVED DURING WET WEATHER	HIGH AMMONIA AND TSS CONCENTRATIONS IN 2 OF 3 SAMPLES	II
	13	TRANSPORTATION CORRIDOR	NON	NON	UNKNOWN	OIL AND SEDIMENTS IN CATCHBASINS	HIGH TOTAL SUSPENDED SOLIDS LOADS	I
	14	OPEN GREEN SPACE	NON	NON	UNKNOWN	NO PROBLEMS OBSERVED	3 OF 3 SAMPLES MEET LEVEL 1 CRITERIA	IV
CONCLUSIONS			5 DRAINAGE AREAS WITH ACCEPTABLE LEVELS OF PROTECTION 9 DRAINAGE AREAS WITH UNKNOWN LEVELS OF PROTECTION APPLICATION FOR A SWCS EXEMPTION NOT POSSIBLE AS SEVERAL DRAINAGE AREAS HAVE UNKNOWN LEVELS OF PROTECTION PROCEED WITH A SCREENING LEVEL STUDY			9 DRAINAGE AREAS WITH ACCEPTABLE LEVELS OF PROTECTION 5 DRAINAGE AREAS WITH UNKNOWN LEVELS OF PROTECTION TWO CATEGORY III AREAS REQUIRE IMMEDIATE ABATEMENT ACTION DETAILED STUDY REQUIRED FOR CATCHMENT AREAS 2,4,5,10 & 13		

PHASE IIb DETAILED STUDY

- CARRY OUT IMEDIATE REMEDIAL WORKS FOR TWO CATEGORY III AREAS
- INVESTIGATE SOURCES, QUANTITY AND QUALITY OF NON STORMWATER DISCHARGES
- MONITOR STORMWATER RUNOFF DISCHARGE FOR A MINIMUM OF 6 EVENTS
- COLLECT RAINFALL AND CLIMATIC DATA
- ANALYZE CONTAMINANT DATA AND CALCULATE LOADINGS

PHASE III SELECTION OF CONTROLS AND ASSESSMENT OF PROTECTION LEVELS

- ASSESS ALTERNATIVE POLLUTION CONTROL MEASURES TO ACHIEVE ALL LEVELS OF PROTECTION
- COST OPTIONS
- PREPARE AND SUBMIT FINAL SWCS REPORT
- IMPLEMENT COST EFFECTIVE MEASURES FOR THE HIGHEST LEVEL OF PROTECTION ECONOMICALLY ACHIEVABLE

DETAILED POLLUTION PROBLEM ASSESSMENT			POLLUTION PROTECTION AND CONTROL MEASURES FOR EACH LEVEL OF PROTECTION			
NATURE	SOURCE	EXTENT	I	II	III	IV
—	—	—	LEAVE UNDEVELOPED	SAME AS I	SAME AS I	SAME AS I
HIGH CONCENTRATIONS LOADINGS LOW	WEEKLY SPILLS FROM CHEMICAL PRODUCT USED TO MAINTAIN MACHINERY	EXCEEDS LEVEL 1 CRITERIA FOR ALL EVENTS	MODIFY MAINTENANCE OPERATIONS TO REDUCE SPILLS	INSTALL AN OIL/WATER SEPARATOR AT SEWER OUTFALL	SAME AS I & II	REPLACE CHEMICAL IN SPILL WITH SAFER NON-TOXIC PRODUCT
—	—	—	MAINTAIN,MONITOR AND AUDIT TREATMENT LAGOON OPERATIONS	SAME AS I	SAME AS I	REPLACE TOXIC CHEMICALS FOR POTENTIAL SPILL WITH SAFER NON-TOXIC PRODUCT
HIGH CONCENTRATION AFTER 8.5 mm OF RAINFALL	BERM CAPACITY TOO LOW	EXCEEDANCE OF LEVEL 3 CRITERIA 9 TIMES PER YEAR	INCREASE BERM CAPACITY FOR LARGER EVENTS	SAME AS I	SAME AS I	SAME AS I
LARGE SPILLS CANNOT BE CONTAINED	SPILL CONTROL PLAN INEFFECTIVE	3 TO 4 TIMES PER YEAR	REVISE SPILL CONTROL PLAN CONSTRUCT SPILL CONTAINMENT TANKS AT CATCHBASIN	CONSTRUCT A SEDIMENTATION BASIN	SAME AS II ENHANCE TREAMENT	SAME AS III
—	—	—	INCLUDE AREA IN SPILL CONROL PLAN	SAME AS I	SAME AS I	SAME AS I
EXPOSED SOIL ON CONSTRUCTION SITE	TOPSOIL STOCK PILE EXCAVATION SITE	1 YEAR CONSTRUCTION PERIOD	IMPLEMENT IMMEDIATELY AN EROSION AND SEDIMENT CONTROL PLAN	SAME AS I	SAME AS I	SAME AS I
—	—	—	MAINTAIN BERMS AND INCLUDE AREA IN SPILL CONTROL PLAN	SAME AS I	SAME AS I	SAME AS I
—	—	—	INCLUDE AREA IN SPILL CONROL PLAN	SAME AS I	SAME AS I	SAME AS I
HIGH BACTERIA COUNTS CONTAMINENT WASHOFF FROM ASPHALT	CROSS CONNECTION WITH SANITARY SEWER SPILL FROM PARKED CARS	EXCEEDS LEVEL 1 CRITERIA FOR ALL EVENTS	CORRECT CROSS CONNECTION INSTALL AN OIL/WATER SEPARATOR	SAME AS I	SAME AS I	SAME AS I
—	—	—	MAINTAIN BERMS AND INCLUDE AREA IN SPILL CONTROL PLAN	SAME AS I	SAME AS I	SAME AS I
WPCP CAPACITY EXCEEDED	WPCP	10 EVENTS PRE YEAR	REDUCE WET WEATHER INFILTRATION AND INFLOW INTO THE SANITARY SEWER SYSTEM	DISINFECT STORMWATER DISCHARGE	INCREASE WPCP CAPACITY	INCREASE WPCP CAPACITY
SEDIMENT WASHOFF FROM ASPHALT	VEHICULAR TRAFFIC	EXCEEDS LEVEL 3 FOR 60 PERCENT OF MONITORED EVENTS	CONSTRUCT A SEDIMENTATION BASIN WITH AN OIL-WATER SEPARATOR	SAME AS I	SAME AS I	SAME AS I
—	—	—	INCLUDE AREA IN SPILL CONROL PLAN	SAME AS I	SAME AS I	SAME AS I

THE NATURE, SOURCE AND EXTENT OF POLLUTION HAS BEEN IDENTIFIED FOR DRAINAGE AREAS 2,4,5,7,9,12 AND 13

TARGET LEVEL OF PROTECTION ECONOMICALLY ACHIEVABLE AND THE PROPOSED METHOD FOR POLLUTION PREVENTION AND CONTROL

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MISA guidelines for conducting a stormwater control study /

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